MACHINERY.

September, 1905.

DRAFTING ROOM OF THE B. F. STURTEVANT CO.

THE new plant of the B. F. Sturtevant Co., Hyde Park, Mass., includes, besides the machine shops, foundry, pattern shop, and other manufacturing buildings, a four-story office building, which is headquarters for the whole business of the company. Here are located the correspondence, designing and drafting offices, the production and cost department, advertising bureau, superintendent's offices, etc. In the basement is a well-equipped printing office devoted to catalogue and circular work. The drafting room occupies the whole of the third floor, while the fourth story is finished and is well lighted through prismatic glass in the north windows, so that it may be occupied by the drafting department when the additional room is needed. From present indications, this space will be put to practical use in the near future, in consequence of the rapid growth of the business of the company, especially since the new plant was completed.

The entrance to the office building is at the center, and there are wide staircases leading to the several floors. At the rear is also an elevator, and on each side of the space devoted to the hall and stairs are large fire-proof storage vaults inclosed in masonry extending from the basement to the top floor. The lower vaults are used by the general offices and the two vaults on the third floor are for the drafting and engineering departments. The entrance to the vaults is through double doors designed by the Mosler Safe Company; each vault is lighted by a single window protected by a fireproof rolling metal curtain.

In Fig. 3 on the next page is a plan of the third floor, showing the general arrangement of the drafting room. The disposition of the vaults and the elevators is such as to divide the room into two main rooms, and each of these is in turn divided into two departments by rows of lockers, as indicated in the plan and appearing also in Figs. 1 and 2. Inasmuch as the products of the B. F. Sturtevant Co. comprise several distinct classes of machinery, this subdivision of the room is really a convenience, since it enables the draftsmen working in each department to be grouped under the direction of an engineer in charge of the designing for that department.

In Fig. 1 is given as nearly a general view of the room as it is possible to obtain. In the foreground are the drawing tables in one of the four sections of the room, while in the distance, beyond the partitions that inclose the hall, can be seen a part of another section of the room. It will be noted that the lighting from the windows is all that can be desired. At the back or north side of the building the windows are placed very near together and extended from the level of the drawing tables to the ceiling. For artificial light a special electric light fixture has been designed and one of these is placed at each table. It consists of a double-jointed, swinging bracket, carrying a 32-C.P. electric light bulb provided with a parabolic reflector. The bulb is attached to the end of the bracket by a swivel joint. It is therefore possible to place the light at any point over the drawingboard, and also to direct its rays in any direction desired by means of the swivel joint. While in many offices drawing boards are fitted with two stationary electric lights, this plan of providing one light, so arranged that it can be used efficiently, has been found entirely satisfactory.

The type of drawing table used is clearly indicated in Fig. 1. The table was designed by the B. F. Sturtevant Co., and has a top measuring 3 x 5 feet, giving ample space for all standard-size drawings. The top is supported by two up-

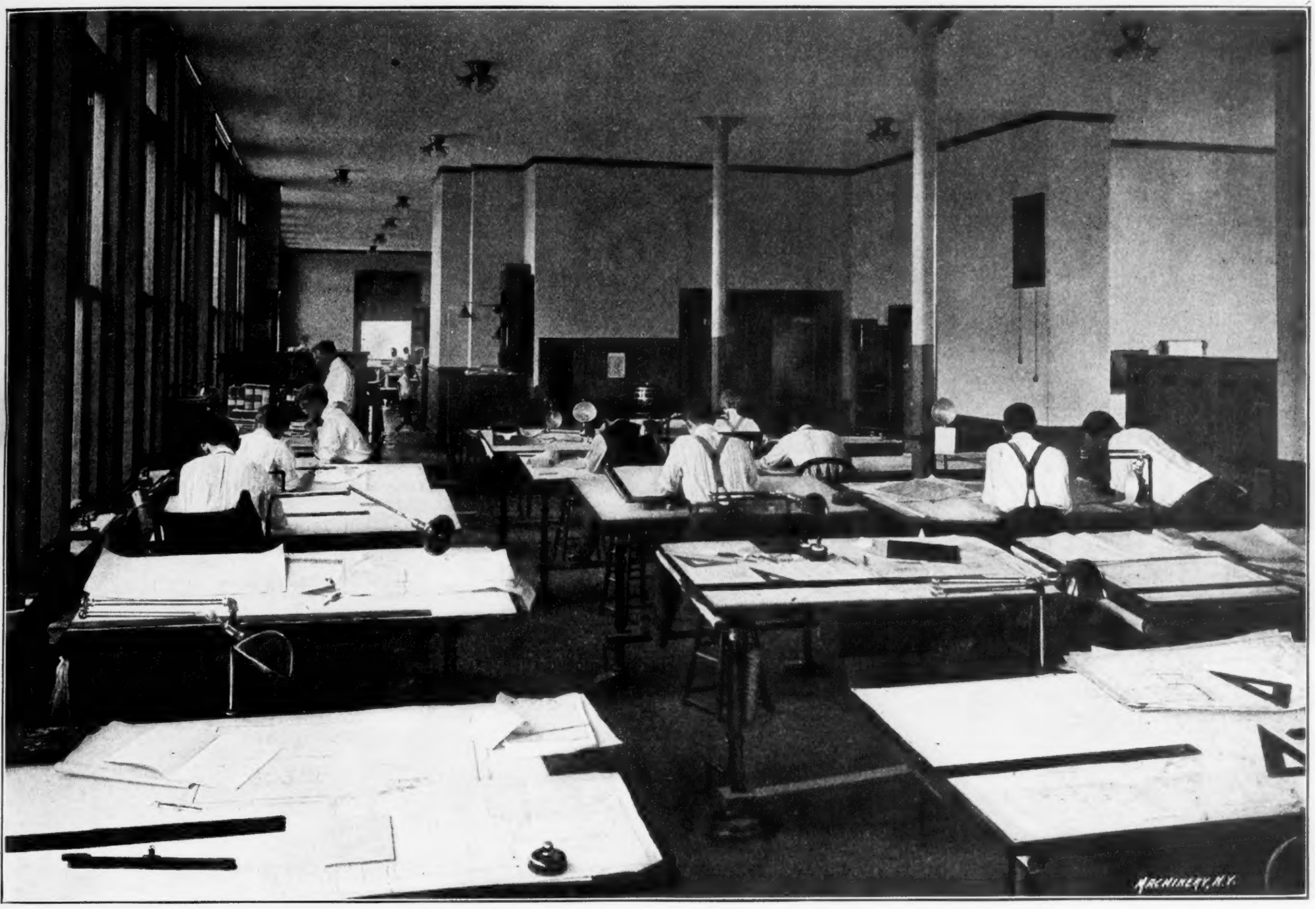


Fig. 1. General View showing one Section of the B. F. Sturtevant Drafting Room.

rights of $1\frac{1}{2}$-inch pipe, screwed into round cast-iron bases fastened to the floor. The upper ends of these uprights fit into adjustable brackets screwed to the underside of the top of the

Fig. 2. View of one Section of Drafting Room, taken from the Center of the Room.

table, supporting it and inclining it to a comfortable angle. The uprights are a sliding fit in these castings, which allows an adjustment of some three or four inches in the height of the table, the position being fixed by setscrews. A wooden foot rest consisting of a long strip extending from one side to the other can be clamped in any position desired by the draftsmen. A single instrument drawer is provided for this type of table.

Fig. 10 shows the details of a longer, 7-foot table of the same general design, which is used by the Sales Engineering Department. It will be noted that the large shallow drawer, intended for drawings, has a horizontal strip at the back to prevent the drawings curling up and slipping out at the rear.

The heating and ventilation of the drawing room, as well as all of the other departments of the plant, is by the Sturtevant forced-blast system. In the office, warm and cold air, mixed under thermostatic control, is admitted through a series of ducts built in line with the rows of lockers, Fig. 3, near the center of the room.

Fig. 4 is a view looking into one of the vaults, which shows the fireproof doors, and Fig. 5, which is an interior view, gives a general idea of the filing cases designed for the drawing and other records.

In Fig. 6 is a view of the blueprint room, which is located in the attic. This room has no unusual features, but is conveniently arranged. There are ample washing trays and drying racks and there are three printing frames that may be used either for printing by sunlight or by electric light. When used with the artificial light the frames remain in the blueprint room and a large hood, or reflector, carrying two small arc

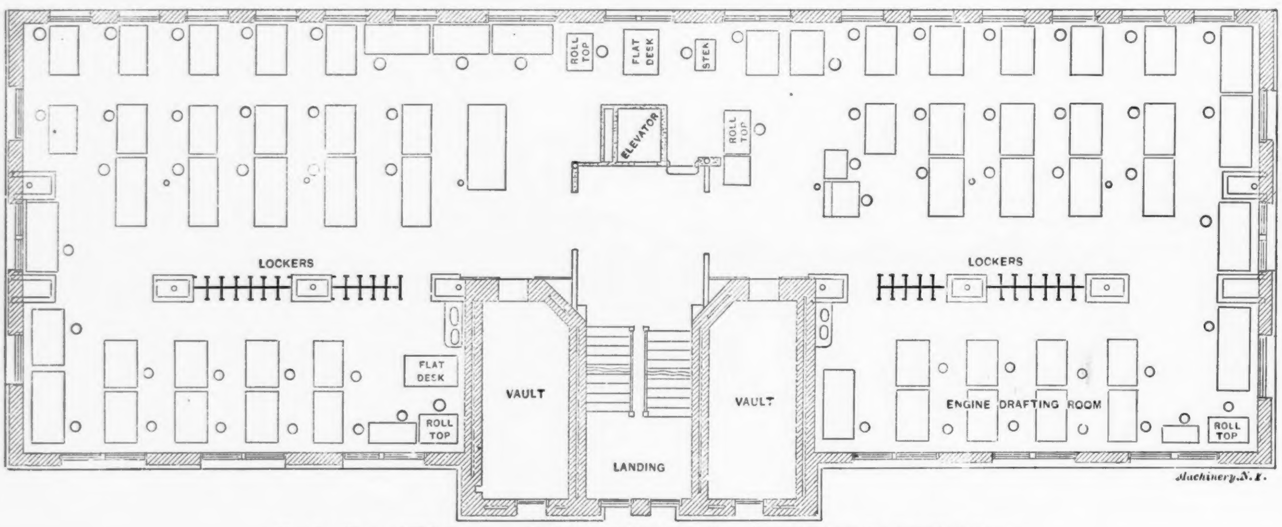


Fig. 3. Plan of Third Floor of Office Building, which is Occupied by the Drafting Room.

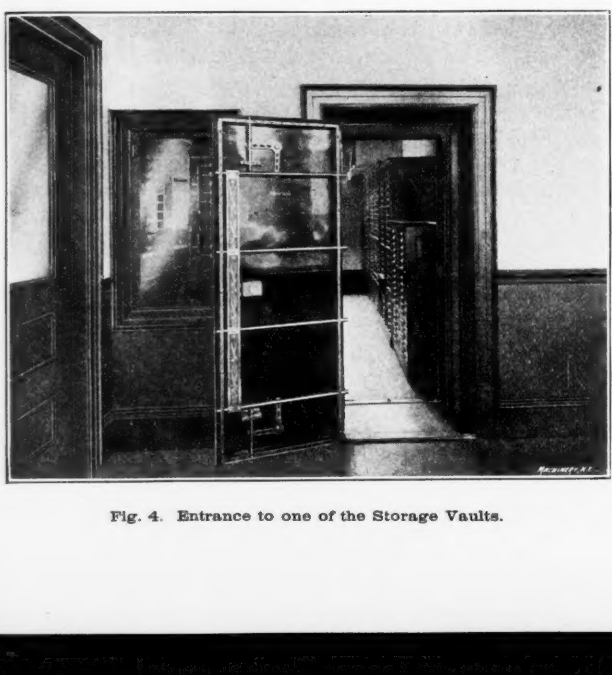


Fig. 4. Entrance to one of the Storage Vaults.

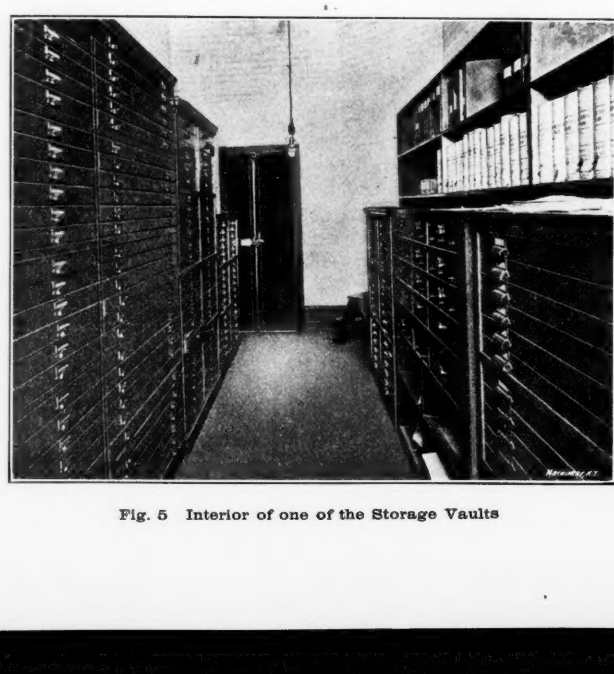


Fig. 5 Interior of one of the Storage Vaults

lamps, is suspended over the frame containing the drawing to be printed. The reflector and lamps are supported by a trolley on overhead tracks, one of which appears at the left in Fig. 6, so they can be located over any one of the three frames for printing in rainy weather or during the latter part of the afternoon.

Fig. 7 shows the platform where the sunlight printing is done, which is arranged in quite an original manner. The office building faces south so that it was necessary to use windows in the front of the building for the printing frames. Inasmuch as these frames would present an unsightly appearance in so prominent a location as the front of the building, the arrangement shown in Fig. 7 was decided upon. It will be noticed that a portion of the roof at the front of the building is cut away sufficiently to allow of a door and windows, to open upon an outer platform, which is substantially on a level with the floor of the blueprint room. This platform, however, is hidden from view by a wall some five feet high around the two sides and front of the platform. This wall is a part of the main wall surrounding the section of the building which contains the entrance, staircases and halls, and which projects a few feet beyond the main wall at the front of the building,

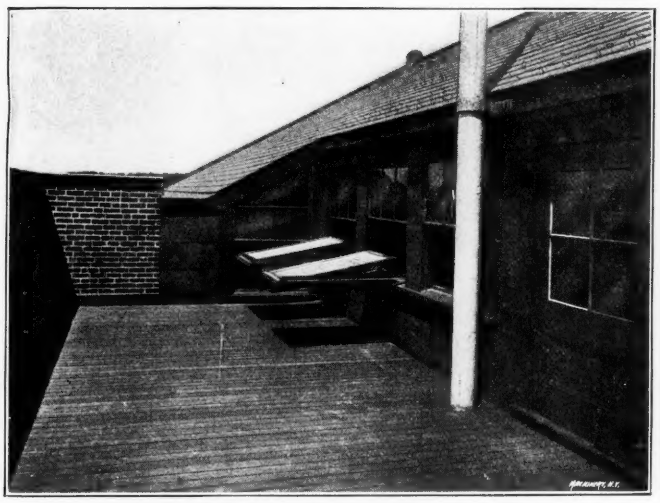


Fig. 7. Platform where Blueprinting by Sunlight is Done.

breaking up what would otherwise be a severely plain exterior, and giving a pleasing architectural effect. By extending this wall to beyond the top floor, as shown in Fig. 7, the blueprint platform was secured with a southern exposure and at the same time it is entirely hidden from view.

Production List—Production Orders.

It is now quite commonly the practice in manufacturing establishments to prepare lists in the drafting room of the parts comprising a machine, giving at the same time the drawing number, the pattern number, etc., for each piece. The B. F. Sturtevant Co. was one of the first to introduce this system, and a copy of one of the production lists is shown on a reduced scale in Fig. 8. This list, as partially filled in in the engraving, is self-explanatory. The blank is printed on thin paper and the different items, with their corresponding numbers, are lettered with black ink so that blueprints can be taken from a sheet for distribution.

The production list is used only in connection with production orders and not in connection with mere shipping orders that may cover the same articles already completed on production orders. One blueprint copy of the production list goes to the production department, and one to the machine department. The former employs it to make out a list of material, etc., for its production orders, the latter as a general reference list.

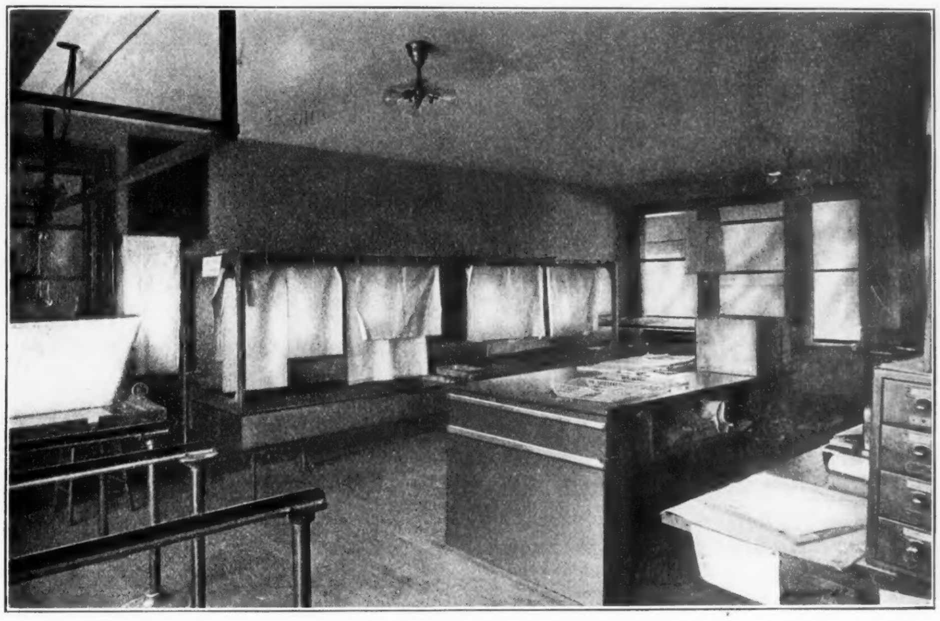


Fig. 6. Interior of Blueprint Room.

In Fig. 9 is a reproduction of a production order which in this case, is issued by the production department to the machine department. This gives the order number for the cylinders of a lot of fifty 10 x 12 engines, twenty-five of which are right-hand and twenty-five left-hand. It gives the pattern number, the drawing number, the number of the production list, states that the cylinders are to be made for stock, etc. The blank also is to be filled in with the time required for

14x16 HORIZONTAL AUTOMATIC ENGINE TYPE · H.C.I.

B. F. STURTEVANT CO., HYDE PARK, MASS. A April 21, 1904.

PRODUCTION LIST T-3351 R. A. S.

ERECTION DRAWING / NAME OF PART.	DRAWING NUMBER.	PATTERN NO. PIECE NO. OR DESCRIPTION.	NO. OF PCS.	MATERIAL.	NAME OF PART.	DRAWING NUMBER.	PATTERN NO. PIECE NO. OR DESCRIPTION.	NO. OF PCS.	MATERIAL.
Bed.	6-1311	14136	1	C.I.					
Bed Cover.		19881	2	C.I.					
Tap Bolts.		$\frac{3}{8}$"x$\frac{3}{4}$"	8	W.I.					
					Cylinder.	6-1305			
Connecting Rod.	6-1308				Body	"	10556	1	C.I.
Body.	"	Pc. 14106	1	Steel	Lagging (St. & Ex. Side)	6-1669	11991	2	"
Crank Box. (Out. Half)	"	14103	1	C.I.	" (Round)	"	11990	2	"
" " (In. Half)	"	14104	1	"	Studs (Back End)	6-1305	$1\frac{1}{8}$"x$3\frac{5}{8}$"	8	Steel
Bolts.	"	Pc. 14105	2	Steel	" (Front End)	"	$1\frac{1}{8}$"x$5\frac{1}{2}$"	8	"
Nut.	"	$1\frac{7}{8}$" Hex.	4	W.I.	Machine Screws.	For Lagging	#20-18		
Split Pins.	"		2	Steel	Nuts.	6-1305	$1\frac{1}{8}$" Hex.	16	W.I.
Wrist Box. (Out. Half)	"	014109	1	Comp.	Steam Chest Studs.	"	$\frac{7}{8}$"x$3\frac{5}{8}$"	12	Steel
Wrist " (In Half)	"	014108	1	"	" " Nuts	"	$\frac{7}{8}$" Hex.	12	W.I.
Strap.	"	Pc. 14107	1	Steel	Head (Front End)	See Pist. Rod Stuff. Box			
Key.	"	Pc. 14110	1	"	Head (Back End)	6-1365	10562	1	C.I.
Bolt.	"	Pc. 14111	2	"	Cover.	"	12234	1	"
Nut.	"	1" Hex.	2	W.I.	Bolt.	"	$\frac{3}{4}$"x$2\frac{13}{16}$"	1	Steel
Set Screw.	"	$\frac{3}{4}$"x$2\frac{1}{8}$"	1	Steel	Jack Screws.	"	$\frac{3}{4}$"	2	"

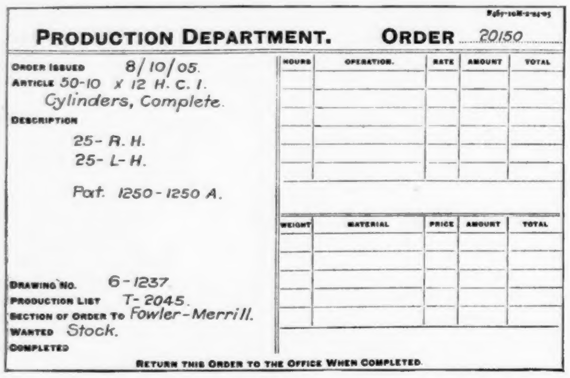
Fig. 8. Production List.

the different operations, and later, in the office with the costs of both the operation and materials entering into the work. This order, as shown, is a general order for the cylinders.

There are also issued sectional orders for each different operation, such as planing, boring, etc., stating the price per piece if the work is to be piecework, and having blank spaces reserved for materials used, the date the work is completed, and when it has received inspection.

Subdivisions of the Office.

As our readers know, the business of the B. F. Sturtevant Co. was primarily the manufacture of blowers. This naturally



PRODUCTION DEPARTMENT. ORDER 20150

ORDER ISSUED 8/10/05.
ARTICLE 50-10 X 12 H. C. I. Cylinders, Complete.
DESCRIPTION
25- R. H.
25- L-H.
Pat. 1250-1250 A.

DRAWING NO. 6-1237
PRODUCTION LIST T-2045.
SECTION OF ORDER TO Fowler-Merrill.
WANTED Stock.
COMPLETED

HOURS	OPERATION.	RATE	AMOUNT	TOTAL

WEIGHT	MATERIAL	PRICE	AMOUNT	TOTAL

RETURN THIS ORDER TO THE OFFICE WHEN COMPLETED.

Fig. 9.

led to various allied branches, such as heating and ventilating apparatus, mechanical draft apparatus, etc. It also led to the manufacture of engines and motors to operate the blowers, and later of generators which are chiefly used in connection with the engines for electric lighting both in stationary power plants and in marine service. Supplementary to the mechanical draft apparatus and other machinery and appliances built for power plant use, have been added the manufacture of economizers, exhaust heads, etc. It will be noted that these several products are, to a considerable extent, different in character, certain of them being such as could be readily manufactured on the interchangeable plan, and others like heating, ventilating and mechanical draft apparatus, being built to meet the needs of each individual customer. These latter, however, are largely made up of standard machines by assembling such sizes of engines, motors, blowers, etc., as may be needed to meet the requirements, the special work thus consisting mainly in the piping, framing, and sheet metal work, which is different in nearly every case.

To facilitate the handling of these lines in the drafting room there are separate departments, over which is an engineer having his own corps of draftsmen who look to him for directions in regard to construction work, although they are under the foreman of the drafting room in so far as the general management of the room is concerned.

One of these departments is the Sales Engineering Department, which attends to all work relating to the combining of individual units, except in the case of generating sets. This is the general drafting department. All designs for fans, heaters, economizers, and the like, as well as the combination of fans and engines, fans and motors, fans and heaters, etc., and all drawings showing applications such as those for mechanical draft, heating and ventilating, exhausting, etc., are made here.

It is the province of the sales engineering department to enter the sales orders for the special apparatus or installations for which it makes the drawings. All the orders for standard goods are entered by the Sales Department. Sales orders are written in manifold, the first copy furnishing the record file copy, the second passing to the production department for binding in a loose leaf binder, the third being retained for checking by the accounting and other departments, and a fourth being made only when necessary as a memorandum to be sent to the branch office from which the order is received. A final copy is made upon a 5 x 8-inch card, commonly known as the shipping card, which passes to the shipping department in the works.

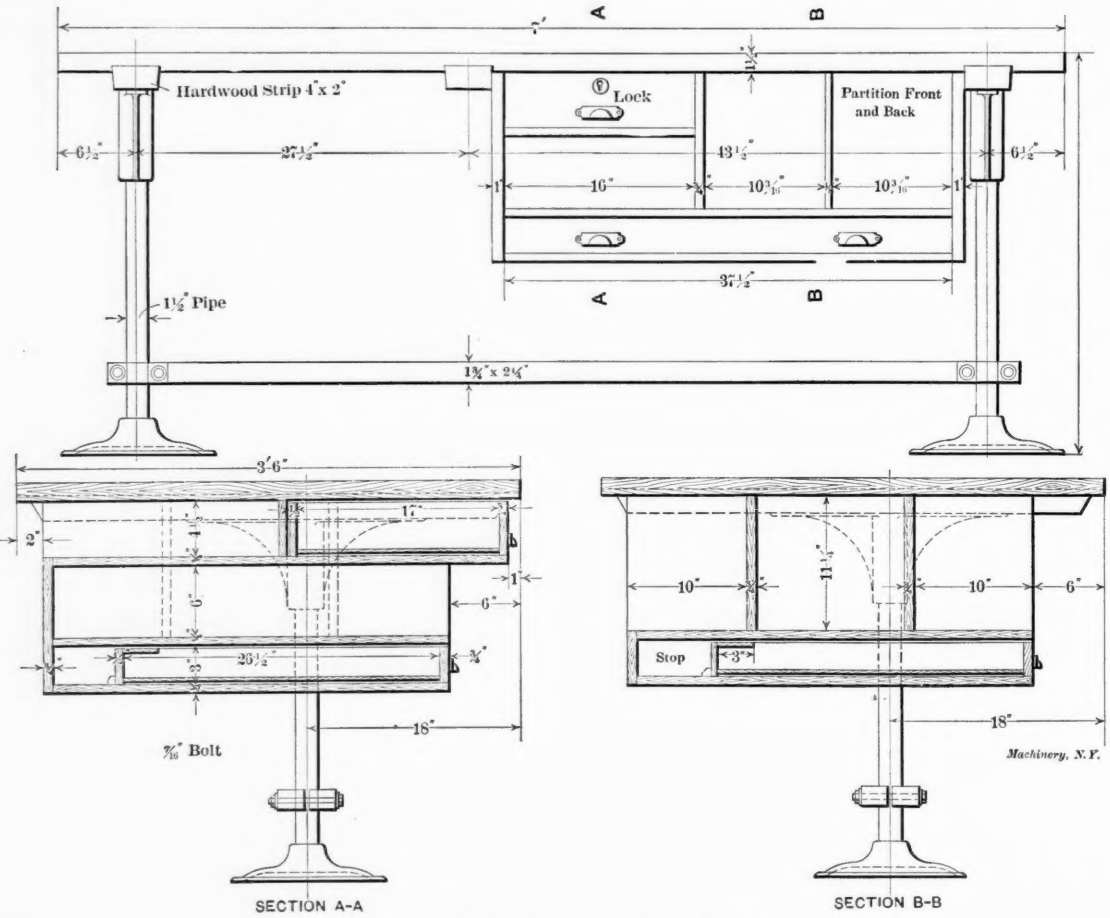


Fig. 10. Details of a Seven-foot Drawing Table.

Drawings.

Drawings are made upon standard size sheets, 9 by 12 inches, 18 by 26 inches, and 24 by 36 inches; the latter being seldom used. Drawings requiring very large sheets are made in multiples of these sizes and folded.

Drawings are designated entirely by numbers. The first number entered on a sheet is indicative of its classification: 6, for instance, indicating engines; 7, electrical apparatus; 15, installations and combinations of apparatus, etc. Following

this number is a dash after which comes the number of the drawing itself in numerical order for the particular class of work shown on that drawing. For example, 15—9145 would indicate drawing No. 9145 of class 15. All numbers are taken consecutively as drawings are made, and locations in the drawer are determined by the card index which is very carefully maintained. Drawings are filed fifty in a drawer. In addition to the designating numbers it is sometimes found necessary to use suffix letters, as, for example, where the group of installation drawings refers to the same plan or building.

Prod. Order 2662 6 **Size** 10 × 10 H. C. 1 Engs.
Prod. List T-1924 Aut.
T-1075 Thrott.

Serial No.	Shipping Order	Shipped	Name	Total of Given Size
9281	98523	Jun. 29/03	Monarch Cotton Mills, Union, S. C.	34
9282	105540	Jun. 25/03	Owosso Sugar Co., Owosso, Mich.	35
9283	104000	Sep. 28/03	Brandon Mills, Greenville, S. C.	36
9284	109470	Oct. 17/03	Portland Co., Freeport, Me.	37

Fig. 11. Record of Shipments.

The drawings of combinations of apparatus such as are prepared by the sales engineering department do not contain details of the different machines, but simply show their relative locations, the dimensions and arrangement of foundations, the castings, heating coils, sheet metal work, framing, etc. The drawings for the regular machine work, however, such as the engine work, contain all details and necessary directions for the workmen. The patterns and piece numbers run consecutively and these numbers are placed on the drawings. There is also a material list showing the number of pieces, the number, name, material, and, where necessary, a column is allowed for explanatory remarks.

In many drafting rooms a great deal of time is spent in lettering the title of the drawing and various plans have been devised to bring about uniformity in the appearance of the title and to reduce the expense of this part of the work. The plan here is to print the name of the firm and other items usually accompanying the title such as the words, "scale," "drawn by," "checked by," "order number," "drawing number," etc., on standard size sheets of tracing paper. This printing is done on a regular printing press with printers' ink. The name of the machine or part of the drawing is then stamped in its proper place, and the several items are filled in by the draftsman, or the persons whose signatures are necessary.

Blueprints intended for shop use are mounted on heavy cardboard; if they are to be in continuous use. Where only a single piece of apparatus is to be made, however, they are not mounted. Aniline sketches are quite generally employed for small apparatus of the latter class. One copy of the sketch is made in a copybook, and card indexed, while others are mounted on cards for shop use.

NO. 9284 SIZE 10 x 10 H.C. 1 Engine. DATE SHIPPED Oct. 17, 03

Shipping Order 109470 — Portland Co., Freeport, Me.
Hand R.H. Runs Over
Steam Pres. 100 Lbs.
R. P. M. 350
Governor Rites.
Band Wheel 48" x 12½
Wt. Wheel 450 lbs.
Eccentric Auto.
Cut off Auto.
Application

Drawing 6-1008
Production Order 2662 Prod. List T-1924
Memoranda:— Thrott. Valve Gravity Oiling System.

Fig. 12. Record of Engines Shipped.

Great care is taken to maintain a complete record of all shipments to facilitate repairs. These records are kept by a card index upon cards 5 by 8 inches in size. To illustrate, as soon as the production order is issued for a lot of engines the serial number of the engine is written on one of these cards; and as fast as the engines are shipped the shipping order is entered in the proper column, together with the date, the name of the customer, and the total number of the given size which have thus been shipped. One of these cards when filled out has entries similar to those shown in Fig. 11. At the same time another 5 by 8 card, of which a reproduction on a reduced scale appears in Fig. 12, is filled out for the specific engine number, and the customer's address and the engine number are entered on a 3 by 5-inch card which is alphabetically filed. The 5 by 8-inch card represented in Fig. 11 is filed by engine size; and the one illustrated in Fig 12, by engine number.

Another vexing problem in drafting room practice is that of taking care of the changes, odd sizes, etc. If the article, after it has been changed, is of such character that it can be substituted for the article first made, the alteration is made upon the tracing; otherwise the blueprint first taken is marked "for record," and shows the piece as it was originally made. The necessary changes are then made on the tracing and a new number given to it. The same policy holds regarding changes in pattern and piece numbers, and in the production lists. In making any of these illustrations the main thing is to be absolutely certain that a specific number for a drawing, patent, or production list always means the same thing.

* * *

STUDY THE MARKET.

That it is necessary for manufacturers to study their markets and adapt their goods to them is at least a half-truth. In many cases a market can be worked up for a new product developed under conditions totally different from those that obtain in foreign countries, but the foreign market having no preconceived ideas as to what the machine or other products should be, accept it without protest. On the other hand, where such preconceived ideas do exist it behooves the manufacturer to go slow in trying to introduce his product if it differs widely from that to which foreign customers are familiar. An example in point is the experience of a certain American bicycle manufacturing concern which made strenuous efforts to introduce American bicycles in Great Britain. It cost them something over $25,000 in advertising and experience before they struck the right track. The manager of one of the English branch houses said: "We have made a success of manufacturing bicycles for the British trade after it had cost us $25,000 in advertising and experimentation. We took hold of the wrong end of the proposition, determining that we would sell the American type of wheel to the Englishman. We were incensed that he wanted the old mud guards that would not be tolerated here. It was folly to us that the Englishman insisted upon the steel rim when we knew wood was so much better. That our perfected hub brake should be overlooked in favor of the old rim brake operated from the handle bar was ridiculous. But after two years and the loss of many thousand dollars, we are making the Englishman's wheel just as the Englishman wants it, and our foreign trade in the bicycle has increased until branch establishments in Liverpool and in London have become necessary to our growing business."

* * *

Before alcohol can come into general use for industrial purposes it must be rendered unfit for drinking. One method for doing this, according to *The Engineer*, and still leave it unharmed for legitimate purposes, is to dissolve in it acetylene gas.

PULLEY AND GEAR ARMS.

ROBERT S. BROWN.

Notation.

b = Belt width in inches. d = Diameter, inches. f = Face, inches.
h = Arm width projected to center of pulley or gear.
h_1 = Arm width at rim. n = Number of teeth in gear.
Pc = Circular pitch. Pd = Diameter pitch.
S = Working stress per square inch of section.
t = Rim thickness. y = Tooth factor in the Lewis formula.
Z = Resisting moment of section.

Elliptical Section Arms.

Elliptical section arms, as in Fig. 1, are commonly used and on ordinary sized pulleys six arms are satisfactory. The

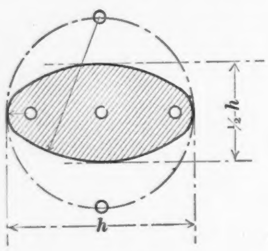


Fig. 1.

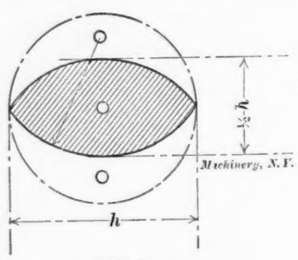


Fig. 2.

following formulas are all based on the use of six arms. For other numbers of arms, see Unwin, Suplee or Reuleaux. Dimension h may taper to h_1, ¼ inch in 12 inches on each side.

$$Z = \frac{h^3}{20.367}, \text{ or roughly, } Z = 0.05\,h^3$$

Lenticular Section Arms.

Lenticular section arms, Fig. 2, are recommended by Unwin as "looking lighter" and have been adopted by Sellers, Sweet and others. In these, $Z = 0.04h^3$, or slightly less than in the elliptical sections. In the formulas following this value for Z has been introduced so that the resulting arms will be strong enough for either lenticular or elliptical section.

Single and Double Armed Pulleys.

Kent assumes a belt pull of 45 pounds for single and 90 pounds for double belts per inch of width. S is taken at

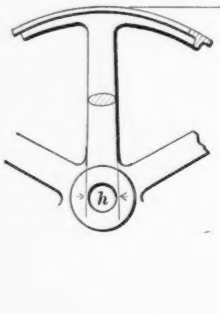


Fig. 3.

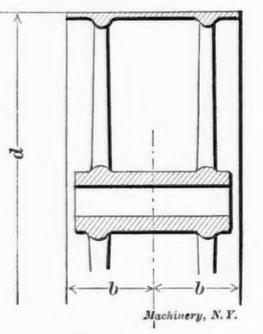


Fig. 4.

3,600 pounds and the belt pull as all coming on one half the number of arms. For single belts, $h = 0.348 \times \sqrt[3]{bd}$. For double belts, $h = 0.4389 \times \sqrt[3]{bd}$. *Log.* $0.348 = \bar{1}.54202$. *Log.* $0.4389 = \bar{1}.64236$.

Above gives results agreeing with Unwin and the table in the International Correspondence Schools' Hand Book. If two sets of arms are used, consider as two pulleys, Fig. 4, and calculate accordingly. Multiply dimensions found by $\sqrt[3]{\tfrac{1}{2}}$ or 0.8 approximately.

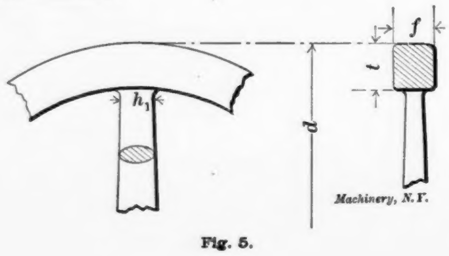


Fig. 5.

Flywheel Arm.

On flywheels, Fig. 5, from 33 to 96 inches diameter, F. A. Halsey, in the *American Machinist*, April 23, 1896, proposes $h_1 = 0.875 + 0.04d + 0.153.\ \sqrt[2]{ft}$ as amply strong and symmetrical. He prefers $f = 2/3\ t$.

Spur Gear Arms.

In gear arms, Fig. 6, S is assumed by Unwin at 5/7 of unit of stress on tooth (3,000 and 4,200 pounds being taken). $h = 0.524\ \sqrt[3]{P_c f d}$ or $h = 0.7677\ \sqrt[3]{\frac{fd}{P_d}}$. Log. $0.524 = \bar{1}.71945$. Log.

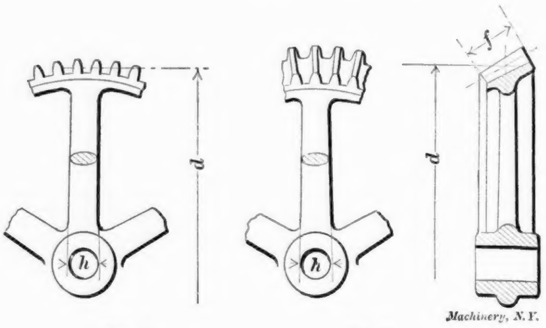


Fig. 6. Fig. 7.

$0.7677 = \bar{1}.88517$. In using the Lewis formula (see Kent pp. 900-1)

$$h = 0.7177\ \sqrt[3]{P_c^2 f y n} \text{ or } h = 1.5395\ \sqrt[3]{\frac{fyn}{P_d^2}}.$$

Log. $0.7177 = \bar{1}.85593$, Log. $1.5395 = 0.1874$. Suplee has a table, p. 466, where $h = 2\ P_c$ and the number of arms is varied with n.

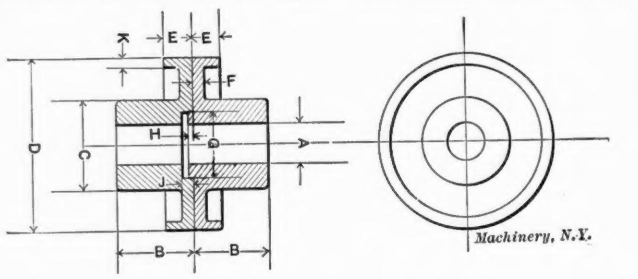
Bevel Gear Arm.

In bevel gears, Fig. 7, use mean diameter and mean pitch and calculate as for spur gears. The above formulas on gears are adapted from the text book of the International Correspondence Schools.

* * *

A CORRECTION.

We regret to say that there is an error in data sheet No. 47, in the August issue of MACHINERY. The cut for the sheet of dimensions for safety flange couplings has been corrected and is shown below. As will be noticed the location of dimension H has been changed. This makes the clearance



between the shoulder on one coupling and the counterbone in the other, a constant amount of 1/32 of an inch. As shown in the cut in the data sheet, the dimensions given in the table would give a constant height to the shoulder of only 1/32 of an inch.

* * *

ALLOYS HAVING LOW FUSING TEMPERATURE.

The following is a list of compositions that will melt at a very low temperature, making them suitable for so-called "safety metals." Any of these compositions will melt at a temperature very much lower than the melting temperature of any of the metals in the composition.

1. Bismuth, 8 parts; lead, 5 parts; tin, 3 parts. This composition will melt at a temperature of 202.1 degrees F.
2. Bismuth, 2 parts; lead, 1 part; tin, 1 part. This alloy will melt at a temperature of 200.75 degrees F.
3. Bismuth, 5 parts; lead, 3 parts; tin, 2 parts. This alloy will melt at a temperature of 196.9 degrees F.
4. Bismuth, 4 parts; lead, 2 parts; tin, 1 part; cadmium, 1 part. An alloy made in this proportion will melt at a temperature of 140.9 degrees F.

SYSTEMATIC METHOD OF COMPUTING CENTRIFUGAL STRESSES.

SANFORD A. MOSS.

In this article is given a convenient system for the computation of stresses in rotating bodies due to so-called "centrifugal force." No derivation or proof of the various formulas is given.

The fundamental quantity of our system will be c, the centrifugal force in pounds, exerted by a concentrated weight of 1 pound, whose center of gravity rotates in a circle one inch in diameter, with a speed of N revolutions per minute. We have

$$c = .00001421\ N^2. \qquad (1)$$

One who has much computation work to do will find it convenient to prepare a table of the values of c for the values of N most frequently used.

The centrifugal force in pounds (that is, the inward radial force which must be applied at the center of gravity), for a concentrated mass whose weight is W pounds, and whose center of gravity rotates in a circle d inches in diameter, is expressed by the formula:

$$\text{Centrifugal force} = cWd. \qquad (2)$$

In computing stresses due to centrifugal force, our fundamental method will be to compute directly F, the "bursting force," in pounds, tending to cause rupture. The stress is of course the bursting force divided by the area. The "bursting force" is understood to be the force in pounds applied to *each* of the two cross-sections of the ring, disk, etc., which are on opposite sides of the axis. That is to say, the total force tending to cause rupture across the whole area on both sides of the axis, cut out by a plane containing the axis is twice the "bursting force."

Rule 3: Hence, in order to obtain the stress, the sum of the bursting forces due to all causes must be divided by the area in square inches of the solid metal (deducting holes, etc.), *on one side of the axis only.* (3)

The use of rule (3) will give only the "average stress," throughout the section. If the cross-section has considerable length in the directions of the radius, the stresses may not be distributed uniformly. Then in various parts of the section, the stress is above and below the average. The exact way in which the stress is distributed is a matter of considerable complexity and uncertainty.

Rule 4: For most purposes it is best to use only the "average stress" as given by rule (3), making the stress and factor of safety such as to allow for any variation of stress above the average which may occur, according to the judgment of the designer. (4).

The section of the disk, ring, etc., should be made such as to give a uniformly distributed stress, whenever possible. For instance, in the case of a disk the thickness (in the direction of the axis) should be much greater at the hub than at the rim. In other words, it is best to place additional metal for resisting stress near the hub where the bursting force of the added metal will be least.

The shape of section which will give uniform distribution of stress can be computed mathematically for any case.

Rule 5: In many cases, it will be sufficient if designer simply thickens the section toward the hub according to his judgment as to what will give uniform stress as nearly as possible under the given circumstances. This is not a scientifically correct procedure, but the mathematical difficulties of the exact methods and the usual large factor of safety justify it. In this case the factor of safety becomes partly a "factor of ignorance." (5)

The bursting force, F, due to n concentrated masses (such as arms, gear teeth or poles on a revolving field), each of weight W pounds, whose centers of gravity are uniformly distributed completely around a circle of diameter d inches is expressed by the formula

$$F = \frac{c\,W\,d}{2 \sin \dfrac{180}{n}} \qquad (6)$$

(6) gives exactly the bursting force across a section midway between two masses, where it is a maximum. The bursting force across the section at the radius through the center of gravity of a mass is less and is found by using *tan* instead of *sin* in (6). The two values are not appreciably different unless n is small.

An approximate formula equivalent to (6) and giving nearly correct results where n is greater than 8, and almost exact results for large values of n, is

$$F = \frac{c\,W\,d\,n}{2\pi} \qquad (7).$$

Next, let us consider the bursting force due to the metal composing a ring, disk, etc., of any cross section. As already remarked, the cross section is the plane figure, on one side of the axis only, cut out by a plane containing the axis.

Formulas for the Bursting Force of a Ring, Disc, Etc.

w = density of metal, pounds per cubic inch.

$W = \pi\, w\, A\, d$ = weight in pounds of the complete disk or ring (whole circumference).

d = diameter in inches of circle through center of gravity of cross section.

$r = \dfrac{d}{2}$ = distance in inches from axis of rotation to center of gravity of cross section.

A = area of cross section in square inches.

I = moment of inertia of plane figure forming cross section, about an axis through its center of gravity, parallel to axis of rotation.

$I' = Ar^2 + I$ = moment of inertia of cross section about axis of rotation.

(A systematic method of finding r A and I was given by the writer in MACHINERY, June, 1903. A condensed method, without automatic checks, for finding A, r and I' is given in the table at the end of the article.)

d_1 = inner diameter of ring or disk in inches.

d_2 = outer diameter of ring or disk in inches.

t = uniform thickness of a flat disk or ring, in the direction of the axis.

F = bursting force in pounds due to metal of ring, disk, etc., applied to cross section on one side of axis.

For a ring, disk, etc., of any cross section:

$$F = 2\,c\,w\,(A\,r^2 + I) \qquad (8)$$

or

$$F = 2\,c\,w\,I' \qquad (9)$$

or

$$F = \frac{c\,W\,d}{2\pi}\left\{1 + \frac{4\,I}{A\,d^2}\right\} \qquad (10)$$

For a ring, whose outer and inner radii are nearly the same, approximate formulas are:

$$F = 2\,c\,w\,A\,r^2 \qquad (11)$$

or

$$F = \frac{c\,w\,A\,(d_1 + d_2)^2}{8} \qquad (12)$$

or

$$F = \frac{cWd}{2\pi} \qquad (13)$$

or

$$F = \frac{c\,W\,(d_1 + d_2)}{4\pi} \qquad (14)$$

The *stress* in a ring whose radii are nearly the same is approximately,

$$\frac{.3732\,w\,V^2}{e} \qquad (15)$$

where V is the velocity in feet per second and e is the ratio of the area effective for resisting stress to the average area, *i. e.*, the "efficiency of joint."

For a flat ring or disk or cylinder with a hole in it, of uniform thickness in the direction of the axis

Sanford A. Moss was born in San Francisco, Cal., in 1872. He served an apprenticeship as a machinist with Edward A. Rix and afterwards became a journeyman machinist with the California Gas Engineering Co. He then entered the mechanical engineering department of the University of California, graduating in 1896. He alternated practical work as a draftsman for various machine works, with post-graduate college work in mechanical engineering at the University of California and at Cornell University, where he received the degree of Doctor of Philosophy. In 1901 Mr. Moss became instructor in machine design at Cornell University, resigning in 1903 to accept his present position in charge of experimental research work for the steam turbine department of the Lynn works of the General Electric Co. His specialty is the mathematical side of engineering.

$$F = \frac{c\,w\,t}{12}\,(d_2^3 - d_1^3) \qquad (16)$$

or

$$F = \frac{c\,W}{3\,\pi}\left(d_1 + d_2 - \frac{d_1\,d_2}{d_1 + d_2}\right) \qquad (17)$$

Computation of Stress in an Impeller.

As an example of the methods of using the preceding formulas, we will compute the stress in the cast iron impeller of a centrifugal pump, 34 inches in diameter, rotating at 1,000 revolutions per minute. The impeller consists of a central disk, with bosses at the center forming the hub. On both sides of the disk are cast ribs forming the vanes. The disk is thickened at the hub so as to make the stress uniform according to rule (5). The thickness in the direction of the axis just outside the hubs is 3 inches. The thickness gradually decreases and becomes ½ inch at the circumference. There are 20 vanes on each side extending from inlet to circumference, and 20 more on each side beginning about half way out and extending to the circumference.

The weight of one of the long vanes was computed to be 4 pounds, and the weight of one of the short vanes was 2 pounds. The diameters to the centers of gravity of the vanes were computed to be 26 and 20 inches respectively. The plane figure forming the cross section of the disk was worked up in tabular form, as shown in the table, and the area found to be $A = 28$ square inches, and the moment of inertia about the axis of rotation found to be $I' = 1143.8$. This data and the preceding formula enable us to compute the stress, as follows:

In the first place, by formula (1)

$$c = .00001421 \times 1000 \times 1000 = 14.21.$$

The bursting force due to the long vanes on both sides by formula (7) is:

$$F_1 = \frac{2 \times 14.21 \times 4 \times 26 \times 20}{2 \times 3.1416} = 9{,}408 \text{ pounds.}$$

The bursting force due to the short vanes on both sides, by the same formula, is:

$$F_2 = \frac{2 \times 14.21 \times 2 \times 20 \times 20}{2 \times 3.1416} = 3{,}618 \text{ pounds.}$$

Next we will compute the bursting force due to the metal of the disk itself, by formula (9). We will take w, the weight of cast iron per cubic inch, as .26. We have,

$$F_3 = 2 \times 14.21 \times .26 \times 1143.8 = 8{,}450 \text{ pounds.}$$

The total bursting force is

$$F_1 + F_2 + F_3 = 9408 + 3618 + 8450 = 21{,}476 \text{ pounds.}$$

This is resisted by the metal forming the cross section of the disk, 28 square inches. Hence the stress is 21,476 ÷ 28 or 767 pounds per square inch. This is a proper stress for cast iron under the circumstances, and hence the impeller is safe.

Computation of Stress in a Flywheel.

Let us take as a second example a six-arm cast iron flywheel, rotating at 100 revolutions per minute, built in halves and held together by the usual steel link-bars at the rim and by bolts at the hub. Let the outside diameter be 12 feet, the inside diameter of the rim 10 feet, and the thickness of the rim in the direction of the axis 12 inches. The total area on each side of the link bars is 16 square inches, and of the cast iron at the minimum section, 128 square inches. Let the hubs be 12-inch bore and 24 inches long, and of a shape equivalent to an outside diameter of 30 inches. Let the average cross section of the arms be 50 square inches. The fillets at the ends, etc., are such that the weight of each arm is the same as that of an arm with a cross section of 50 square inches, which is 52 inches long. The estimated radius to the center of gravity of the arms is 35 inches. The hub is held together by two 2¼-inch bolts on each side; area at root of thread, 3.14 square inches each.

In the first place, by formula (1)

$$c = .00001421 \times 100 \times 100 = .1421.$$

The weight of an arm is $50 \times 52 \times .26 = 676$ pounds. The bursting force due to the arms by formula (6), is

$$F_1 = \frac{.1421 \times 676 \times 70}{2 \times \sin 30^\circ} = .1421 \times 676 \times 70 = 6{,}724 \text{ pounds.}$$

The approximate formula (7) would have given

$$\frac{.1421 \times 676 \times 70 \times 6}{2 \times 3.1416} = 6{,}421 \text{ pounds.}$$

which is considerably in error.

The bursting force due to the hub by formula (16) is

$$F_2 = \frac{.1421 \times .26 \times 24}{12}\,(30^3 - 12^3) = .1421 \times .26 \times 2 \times 25272 = 1{,}868 \text{ pounds.}$$

The bursting force due to the rim, by formula (16) is

$$F_3 = \frac{.1421 \times .26 \times 12}{12}\,(144^3 - 120^3) = .1421 \times .26 \times 1{,}258{,}000 = 46{,}480 \text{ pounds.}$$

The approximate formula (12) would have given $\frac{1}{8} \times .1421 \times .26 \times 144 \times 264^2 = 46{,}350$ pounds, which is nearly correct.

Let us suppose that the rim takes care of its own bursting force, and the hub supports itself and the arms. The stress on the link bars is then $46{,}480 \div 16 = 2{,}900$ pounds per square inch, and on the cast iron is $46{,}480 \div 128 = 363$ pounds per square inch. The total bursting force on the hub bolts is $6724 + 1868 = 8{,}592$ pounds, and the stress is $8592 \div 6.28 = 1{,}370$ pounds per square inch. These stresses are extremely low and the wheel is therefore of ample strength.

Table showing Systematic Method of Finding the Moment of Inertia of any Plane Figure about any Given Axis.

(The axis may or may not be the axis through the center of gravity. If the bursting force of the figure is being computed, the axis should be the axis of rotation.) The figure must first be divided into rectangles or triangles, whose bases are parallel to the given axis. These subdivisions are labeled A, B, C, etc., in Col. 1. They are marked R or T in Col. 2 according as they are rectangles or triangles. The breadth parallel to the axis is placed in Col. 3 and the height, perpendicular to the axis, in Col. 4. The distance of the center of gravity of each subdivision from the given axis, is placed in Col. 5. The center of gravity of a rectangle is at one-half its height, and of a triangle at one-third its height.

1	2	3	4	5	6	7	8	9
Part.	Rectangle or Triangle.	Breadth.	Height.	Distance of C. of G. from Axis.	$bh/2$ if T, bh if R.			$x \times ax$ and $\frac{bh^3}{36}$ if T, or $\frac{bh^3}{12}$ if R.
		h	h	x	a	$a\,x$	h^3	
A	T	2.28	9.68	9.04	11.03	99.8	907.0	902.0 57.4
B	R	1.18	3.86	3.93	4.56	17.9	57.51	70.3 5.7
C	R	1.11	4.02	3.81	4.46	17.0	64.96	64.8 6.0
D	T	1.92	1.90	2.63	1.82	4.8	6.86	12.6 0.4
E	T	1.60	1.76	2.71	1.41	3.8	5.45	10.3 0.2
F	R	1.90	0.30	1.97	0.57	1.1	0.03	2.2 0.0
G	R	6.62	0.625	1.69	4.14	7.0	0.24	11.8 0.1
......	......	......	......	......	27.99	151.4	......	1143.8

Area $= A = 28.$ square inches.
Moment of inertia about given axis $= I' = 1143.8$.

(*Additional Properties.*—Distance of center of gravity from given axis, $= r = \Sigma\; ax/A = 151\,4/28 = 5.41$ inches. Moment of inertia about neutral axis, *i. e.*, axis through center of gravity, $= I = I' - A\,r^2 = 1143.8 - 819.3 = 324.5$). .. ....

* * *

The ammeter may be successfully used as a speed indicator by connecting it to a small dynamo having a permanent field magnet, the dynamo being driven, of course, directly from the part the speed of which is to be measured. With such a dynamo the deflection of an ammeter needle is directly proportional to the speed.

CONE PULLEY RADII.

JOHN J. HARMAN.

The problem of determining the radii of a single pair of pulleys to transmit a given velocity ratio is so very elementary in its nature that one would not at first thought imagine it to be a difficult matter to proportion a series of these pulleys on the same shafts to transmit other given velocity ratios. However, this calculation, when an open belt is to be used, is probably of a more complex nature than any other minor operation in machine designing.

The one condition which causes a multitude of troubles is the fact that the same belt must fit with equal tension on the different steps—or pulleys—of the cone. This condition makes the problem an exceedingly difficult one for exact analytical solution. Approximate formulas are to be found in Kent's "Mechanical Engineer's Pocket Book," and other engineering treatises of the same nature, which handle the problem from a purely analytical standpoint, but they are at best very complicated and laborious calculations. The graphical solution by C. A. Smith, which is to be found in "Kent," is hardly more feasible than these analytical solutions. Prof. J. F. Klein, of Lehigh University, however, has presented a graphical method, which is a modification of one originated by Prof. Culmann, and which is far superior to any of the methods previously mentioned. It has the advantage that it is theoretically accurate; but it has the marked disadvantage that the curve used has to be constructed from a series of ordinates, and then drawn in by means of a curved ruler. This method was thoroughly described by G. A. Goodenough, of the University of Illinois, in the *American Machinist*, October 29, 1896. Three other methods of considerable merit have come under the observation of the writer, which are very similar to each other, and are also similar to the method that is to be described in this article. The methods referred to are those of H. W. Spangler, Assistant Engineer United States Navy (*Journal of the Franklin Institute*, February, 1883); of Lucien E. Picolet, this being a modification of Spangler's method (*American Machinist*, February 18, 1904); and of Prof. W. K. Palmer, University of Kansas (*American Machinist*, July 14, 1898).

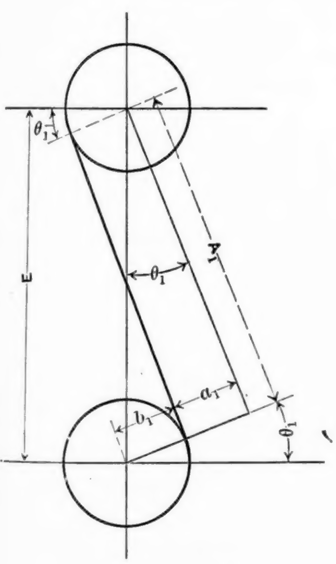


Fig. 1.

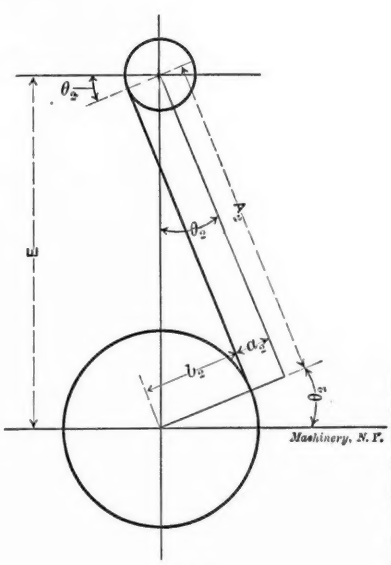


Fig. 2.

Having observed these various methods which appear to the writer to be of lesser merit, it has been a matter of some surprise to him that he has never seen advocated the elegant method presented by Dr. L. Burmester in his "Lehrbuch der Kinematik." Dr. Burmester's method is entirely graphical, and is exceedingly simple in application. While it is not theoretically exact, it is, as will be shown later, much more accurate than practice requires.

In order to bring out more clearly the points which will come up in the case of open belts, let us first consider the simple case of crossed belts. It is a well known fact that in this case the only calculation necessary in order to find the radii of the various steps is to make the sum of the radii of any two corresponding steps a constant. This may be shown in the following manner:

Notation:

a = radius of step, driving cone.

A = length of belt from contact on driving cone to contact on driven cone.

b = radius of step, driven cone.

E = distance between centers of cones.

K = a constant.

θ = angle shown, Figs. 1 and 2.

Note: A subscript applied to a letter denotes that the letter is the one used in the corresponding figure; thus, a_1 refers to a in Fig. 1.

Then

$$\sin \theta_1 = \frac{a_1 + b_1}{E} = \frac{K}{E}$$

$$\sin \theta_2 = \frac{a_2 + b_2}{E} = \frac{K}{E}$$

Therefore $\theta_1 = \theta_2 = \theta$, a constant.

Therefore the arc of contact on each pulley $= 180° + 2\,\theta =$ a constant.

$$\text{Also } \cot \theta = \frac{A_1}{a_1 + b_1} = \frac{A_1}{K} = \frac{A_2}{a_2 + b_2} = \frac{A_2}{K}$$

$$A_1 = A_2 = K \cot \theta, \text{ a constant.}$$

$$\text{But length of belt} = 2\,A + \frac{180° + 2\,\theta}{360°} \times (2\,\pi\,a_1 + 2\,\pi\,b_1)$$

$$= 2\,A + \frac{180° + 2\,\theta}{360°} \times 2\,\pi \times (a_1 + b_1)$$

and, as has been shown above, all the terms are constant, therefore length of belt is constant.

The radii of the various steps may be determined graphically by the following diagram (Fig. 3):

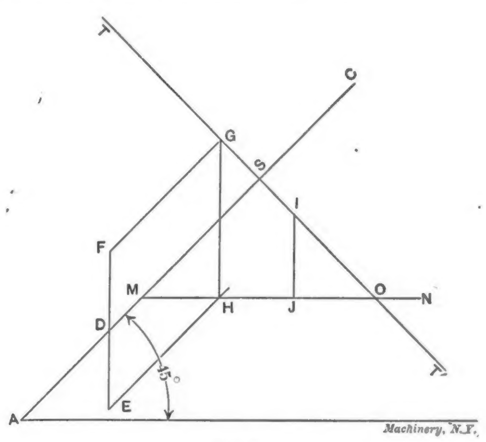


Fig. 3.

Draw the horizontal line AB, and from A draw AC making an angle of 45 degrees with it. On this line lay off AS equal to (E) the distance between the cone centers; using any scale most convenient, bearing in mind, however, that the scale adopted now must be used consistently throughout the diagram. At S erect the perpendicular TST' to the line ASC. From some convenient point on AC, as D, drop a vertical equal to some known radius of the cone A, as DE, and then from E measure back on this vertical the radius of the corresponding step on cone B, as EF, and from these points E and F draw lines parallel to ASC. From the point G, where the line FG intersects the line TST', drop a vertical. This will intersect the line EH in H. Through H draw the horizontal MN, O being the point where this line intersects the line TST'. Then, distances on the line MO may be taken to represent radii on cone A; and to find the corresponding radii on cone B erect perpendiculars at the extremities of these radii, producing them until they intersect the line TST'. These perpendiculars then represent the desired radii. It may be shown as follows that the sum of the two corresponding radii, as obtained from this diagram, is always a constant, and the diagram therefore satisfies the conditions for crossed belts.

Let MJ represent any radius on cone A, then JI represents the corresponding radius on cone B.

The $\angle JIO = \angle JOI = 45$ degrees.

Therefore $JI = JO$.

Therefore $MJ + JI = MJ + JO = MO$, a constant.

Dr. Burmester's diagram for open belts is a modification of the diagram just shown, the only difference being that the line TST' is replaced by a curve. This curve was determined by plotting a series of points, and after several pages of exceedingly intricate mathematics he arrived at the astonishing result that this curve could be replaced by a simple circular arc without any appreciable error.

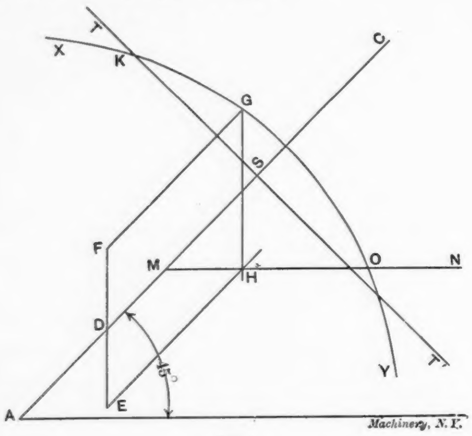


Fig. 4.

The diagram is shown in Fig. 4, and may be drawn as follows: Proceed as in Fig. 3 until the line TST' is drawn, then lay off SK equal to $\frac{1}{2} AS$ $(= \frac{1}{2} E)$. Next, with a center at A and a radius equal to AK describe the arc XY, and the diagram is ready for use.

In order to give an idea of the extreme accuracy of the diagram, let us observe the values obtained by Dr. Burmester in his calculations.

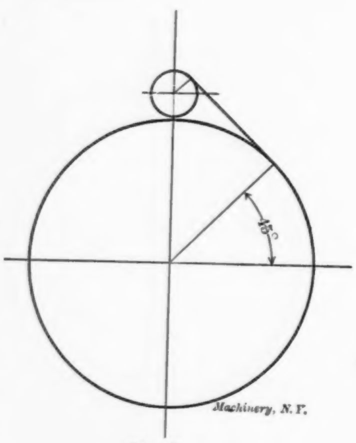


Fig. 5.

Required:

All diameters of driven cone.

Lay out the diagram and determine the point M as previously directed. Now the radii of driving cone may be laid off as abscissas or ordinates, whichever happens to be the more convenient, as the results obtained will be exactly the same in either case. In this particular problem it is evidently more convenient to lay them off as abscissas. Then the ordinates erected at the ends of these abscissas will represent the corresponding radii of the driven cone. The problem is solved in Fig. 6 and the following results obtained:

Results:

Diameter of driven cone 22½", 19⅜", 14", and 7¼".

This problem does not bring out all of the beauties of the diagram, so let us solve a more complicated one, in which the different steps of the cone are to transmit given velocities.

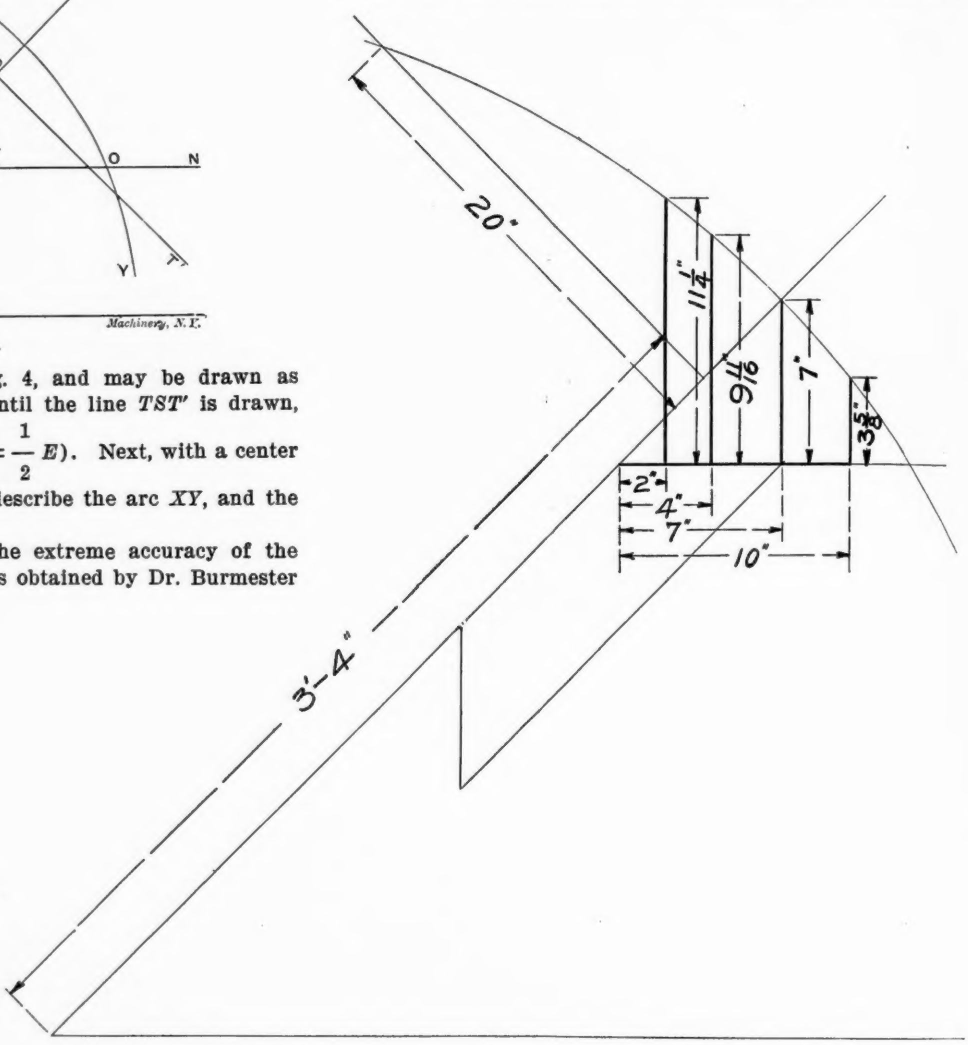


Fig. 6. Solution of Cone Pulley Problem when Diameters of one Pulley and Center Distance are Known.

Let $R = AK$ (Fig. 4).

When $\theta = 0$, $R = E \times 1.11815172$.

$\theta = 15°$, $R = E \times 1.11806842$.

$\theta = 30°$, $R = E \times 1.11798671$.

$\theta = 45°$, $R = E \times 1.11803397$.

The value used for R in the diagram is $E \times 1.11803397$; so the maximum error of R occurs when $\theta = 0$, and is equal to $E \times .00011775$, which is much more accurate than the work of the most careful draftsman. Dr. Burmester gives values of R up to $\theta = 90°$, but as it is evident from Fig. 5 that it would be practically impossible to have a value of θ greater than 45°, the writer has omitted the other values.

In order to make the use of the diagram perfectly clear, let us solve the following problems:

Problem 1. (Fig. 6).

Given:

Distance between centers of cones = 3′ 4″.

Diameter driving cone 4″, 8″, 14″, 20″.

Diameter driven cone X, X, 14″, X.

Problem 2 (Fig. 7).

Given:

Distance between centers of cones = 3′ — 4″.

Maximum velocity of belt (assumed) 30 feet per second.

R. P. M. of driving cone = 240.

Required:

Driven cone to make 100, 240, 400 and 580 R. P. M.

The maximum belt speed will be attained when the belt is on the largest step of the driving cone.

$$\text{Therefore} \quad \frac{2\ \pi\ a_1 \times 240}{12 \times 60} = 30$$

$$2a_1 = 28⅝''$$

$$\text{But} \quad \frac{2b_1}{28⅝} = \frac{240}{580}$$

$$2b_1 = 11⅞''.$$

Now having obtained a value for a_1 and b_1, the point M on the diagram may be found. Next draw a line from M as MO,

inclined so that any horizontal projection, as *MN*, will be to the corresponding vertical projection, *NO*, as the R. P. M. of the driver are to the R. P. M. of the driven; thus,

$$\frac{MN}{NO}=\frac{\text{R. P. M. of driving cone}}{\text{R. P. M. of driven cone.}}$$

Also from similar triangles

$$\frac{MN}{NO}=\frac{MN'}{N'O'}$$

But we know that

$$\frac{\text{R. P. M. of driving cone}}{\text{R. P. M. of driven cone}}=\frac{\text{rad. of driven cone}}{\text{rad. of driving cone}}$$

Therefore *MN'* equals radius of driven cone, while *N'O'* equals radius of driving cone, thus making, for this case, radii of driving cone vertical and of driven cone horizontal. The problem is solved in Fig. 7 and the following results obtained:

Results:

Dia. of driving cone 28⅝", 25⅝", 20¾", 11⅞".
Dia. of driven cone 11⅞", 15⅜", 20¾", 28⅝".

We have seen that the Burmester diagram is under all conditions much more exact than is required in practice; and a more compact, simpler, or quicker method of finding cone pulley radii could not be desired. An experienced draftsman should be able to solve a problem like No. 2 above in less than 10 minutes, while to obtain the same results by an analytical method would require as many hours. Results of sufficient accuracy can usually be obtained by making the diagram to half scale, although there is no reason for reducing the scale, unless the distance between centers is inconveniently large, and in that case the results do not need to be so accurate as the belt will stand more stretching.

* * *

INSTRUCTIONS FOR DRAFTSMEN.

EDWIN W. BEARDSLEY.

The following instructions are intended to be, for the most part, or with minor changes, applicable to the practice of the average drafting room, and, for that reason, are usually confined to principles. Disagreement will often be found with those which are not principles, but they represent excellent practice. They are very largely the result of notes made from time to time for several years as I have seen the needs when checking drawings. I have tried to condense as much as possible into few words, but my object has been to require but a few minutes to hurriedly read the whole and to thus make it easier for a beginner to read them every day, or a tired checker to glance them through, occasionally, for pointers that might have slipped his mind.

DETAIL DRAWINGS.

Scale.

Make details to a scale large enough to distinctly show all parts and also to give sufficient room for necessary dimensions. This will sometimes require two or more times actual size. Do not use an unnecessarily large scale when it will also require a larger sheet than is necessary.

Views.

The views required are those necessary for completely and plainly showing the piece—no more, no less—except that one view is sufficient if another would show no more than is given by "4" dia.," "¼" thick," etc., on the one view.

Show pieces in the position they occupy on the construction drawing or on the completed work, when there is no disadvantage in doing so.

Do not leave wider "open" spaces between the several views of one piece than between those and the views of nearby pieces. Do not crowd views so closely together that there will not be sufficient room for dimensions and notes.

Show long pieces, with a portion of the length broken out when a larger scale than full length would allow is desirable, but do this only when a continuous portion of parts fully shown is thus broken out, or when notes fully explain the omitted portion.

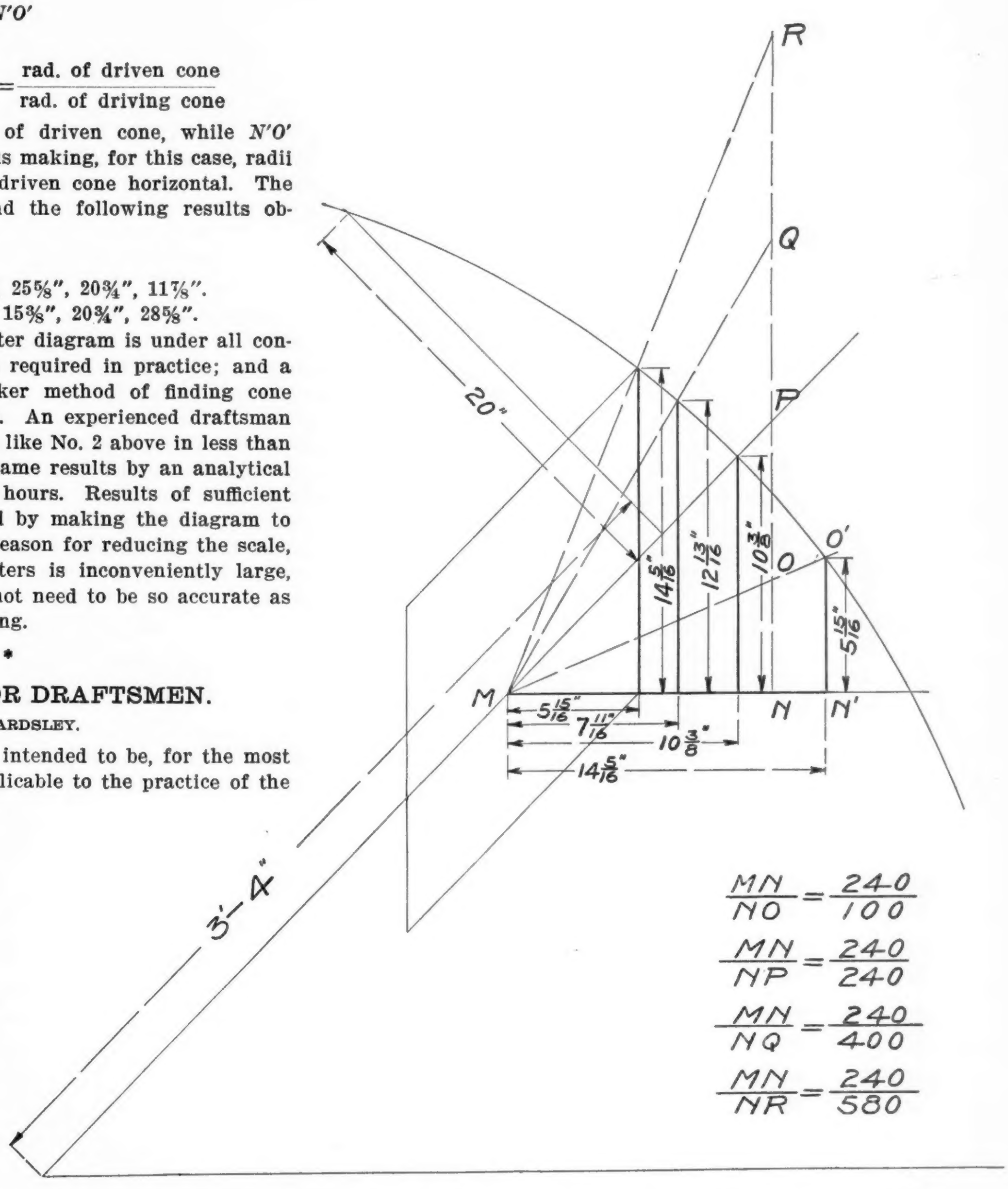


Fig. 7. Solution of Cone Pulley Problem when Desired Velocity Ratios, Maximum Belt Speed, Center Distance and R. P. M. of Driver are known.

A part of a view may be shown when the remainder would be only a repetition of what is plainly shown elsewhere.

Always use "third angle" projection; that is, place views nearest the side of adjoining view which they show. Follow the same principle of direction of view in sections, making them on the side where the outside view of the cut-away portion would be. Any deviation from this rule must be very plainly noted on the drawing.

Always draw both right-hand and left-hand pieces when both are to be made unless the differences are so simple that one or two dimensions can be noted for each without confusion. If the pieces are castings and but one pattern is required, make notes to that effect, mentioning changes. This also applies to similar pieces cast from one pattern with changes, when a detached view, or portion of one, would often show the change.

Lines.

Make outlines in medium or heavy lines, giving strong contrast with dimension and center lines, which must always be light but distinct.

Make section lines not less than 1-16 inch apart, except on widths of less than ⅛ inch. Make them lighter than the outline. On ordinary work, narrow sections may be hatched free-hand.

Have no "hair" lines in figures, letters or outlines.

Do not make the line which shows an obtuse angle corner as heavy as the outline.

Dimensions.

Give all the dimensions necessary to make the piece—no more, no less—and do not repeat on same nor on different views of the same piece unless for a special reason.

Give dimensions so that the workman will not have to do any important figuring himself.

Give dimensions where and as they will be most useful to the workman.

Do not give dimensions from the center line of a piece when it is not necessary.

Give dimensions from something that the workman can and should measure directly from, if reasonable to do so.

Give dimensions between places having a definite relation rather than otherwise.

Place the shorter dimensions nearest the outline.

Place dimensions so that there need be no doubt as to what they refer.

Do not repeat a dimension many times in a single line where the likeness is clear from the drawing. At most, give it two or three times and then include the remainder, or the whole, in a dimension reading like this: 12 spaces at 9″ = 9′ — 0″.

Never crowd dimension lines or figures.

Run the limiting line slightly beyond the end of the dimension line.

On a piece having several diameters in its length, or in similar holes, give the diameters on side view, or section, rather than on end view.

Where two things are centrally spaced in relation to a third, and also definitely related to each other, give one dimension from the center to one and another between the two.

Where an inside dimension is given on an outside view and is not much different from it, make distinct by marking "inside," or by giving, in line with it, the remaining dimension.

Do not call for impossible or unnecessary accuracy. If a dimension is calculated 18 1-64 inches and the work is so rough that inaccuracies of 1-16 inch are provided for, leave off the 1-64 inch, but do not disregard the correct figure in further calculations.

When a dimension is not to scale and piece is not shown broken, mark the dimension "make."

Give angles from existing surfaces, or, so that no figuring will be required of the workman in order to measure the angle.

Make the dimension line for an angle an arc with its center at the vertex of the angle. Mark figures "deg." and "min." Do not use their signs.

Mark radii "rad," or "R."

Place dimensions in the space, and reading in the direction to which they apply when greater distinctions or convenience would not be obtained otherwise. When the space is too small for the figures place them nearby and in such relation that they cannot be misunderstood. Usually an arrow is required running to the space.

Figures and Signs.

Never put letters, figures, signs or arrowheads on, nor running into, each other, the outline of the piece nor any but their own dimension lines.

Make figures and lettering read from the bottom or from the right-hand end of the sheet, always parallel with one or the other, except dimensions on lines necessarily on an angle and on radii and the degree measuring angles, which may read on an arc of the angle.

Make figures and letters large enough and heavy enough to be distinct—not less than 5-64 inch or 1-12 inch high on ordinary work. That size for fractions and ⅛ inch to 5-32 inch for whole numbers is good practice.

Make the dash between feet and inches distinct so that 3′—4″ shall not be mistaken for 34″.

Make arrowheads plain and neat. Make them blunt if there is danger of doubt as to the line they designate.

Use open and distinct forms of figures and letters.

Make inch and foot marks distinct, but much smaller than the figures.

Make whole numbers by fractions large enough that they will not be mistaken for a part of the fraction.

When space is not necessarily limited in height, use the horizontal vinculum, or separating line in fractions: $\frac{1}{2}$ rather than 1/2″.

Notes and Lettering.

Put notes on the drawing whenever necessary for a distinct understanding of the requirements, as when one part is to have a certain fit with another, except where same is otherwise provided for, as by gages, micrometer measurements, or in some cases it may be by the construction drawing.

Express things in notes whenever they will be plainer that way than by further drawing or dimensions.

On rough work it is often well to note character and use with size of holes, thus: "drill 17-32" for ½" bolts," "punch 9-16" for ½" bolts," "core ⅝" for ½" bolt," "ream for ½" shaft," "bore for sleeve No. 65."

When there might be a question about them, mark cast holes whether cored or cut in pattern.

On work having little finishing, mark such surfaces finish, bore, drill, turn, etc.

Run leading lines from notes to holes or other features to which they apply, unless their relation is very plain. Make them free-hand, light, with black ink and an arrowhead at the end indicating unmistakably to what it refers.

Avoid words and phrases which might be easily misunderstood, or not understood at all.

When a note consists of more than two lines, make them match, vertically, on the left-hand side.

Make spacing between lines of lettering in notes uniform and not wider than the height of the letters.

Except in simple cases, name the sections of a piece and show by a light broken line where they are taken. Letter the ends to the line to read from the side that would be removed to show the section as drawn.

Make all lettering in capitals, vertical, or very slightly inclined to the right and of uniform height.

Make titles, names of sections, views and pieces with letters ⅛ inch high, other lettering 1-12 or 5-64 inch high.

Never dot capital I.

General.

Exercise your "gray matter" a little before doing things rather than "the boss's" patience afterward.

A rule is sometimes best observed in the breaking rather than the keeping. Heed the spirit as well as the letter of all instructions.

The men who make the pieces are not draftsmen and should not be supposed to know more about a piece than is given on the drawing.

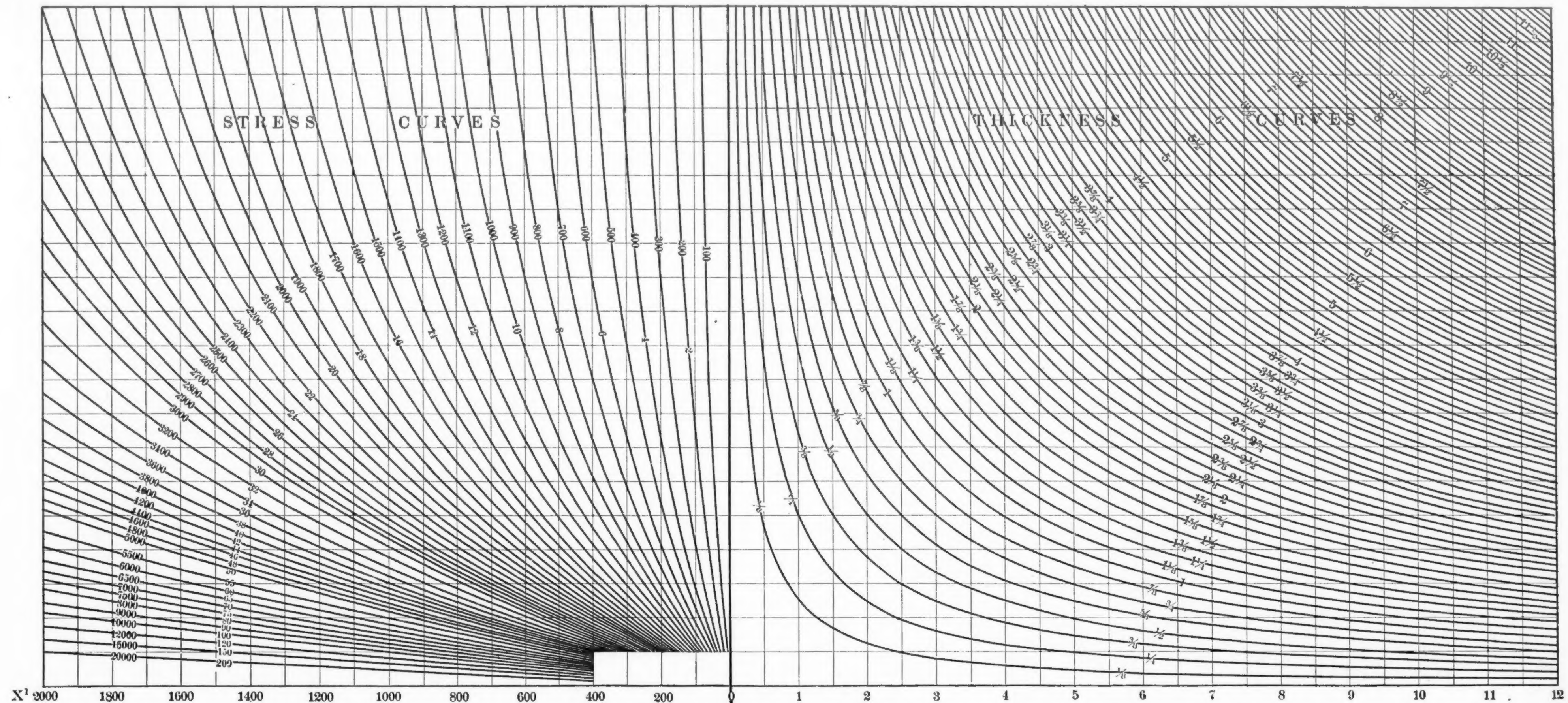
A drawing is plainer to the man who makes it than to the mechanic who first sees it when he is started on the work. Consider what you would want to know if you were to make the piece correctly under the workman's circumstances.

Strive for clearness, completeness, simplicity and neatness.

* * *

Mention was made in these columns some time ago of a technical dictionary which is in course of preparation by the Society of German Engineers. We have received from them a short report of the progress they are making in the work. It will be remembered that this dictionary is to include the technical and trade vocabulary of the English, German and French languages. The report states that up to June, 1905, they received 2,700,000 word cards from about 2,000 firms and individual collaborators at home and abroad. To these will be added the hundred thousands of cards that will result from the working out of the original contributions not yet taken in hand.

The Editor-in-Chief will be pleased to given any information required in regard to this work. Address Technolexicon, Dr. Hubert Jansen, Berlin (N. W. 7), Dorotheenstrasse 49.



CURVES FOR SOLUTION OF PROBLEMS IN DESIGNING THICK CYLINDERS

THICK CYLINDERS.

JOHN S. HOLLIDAY.

The thickness of wall in cylinders for high pressure must be determined partly from experience. In all cases a large factor of safety must be employed to allow for imperfections in the metal, strains due to outside causes, etc. In the determination of the factor of safety, the designer must be guided by current successful practice.

The most generally accepted formula for the thickness of wall is that of Lamé. It is as follows:

$$t = \frac{d}{2}\left(\sqrt{\frac{S+P}{S-P}} - 1\right) \qquad (1)$$

in which

t = thickness of wall in inches.

d = inside diameter of cylinder in inches.

P = working pressure in pounds per square inch.

S = stress in cylinder wall in pounds per square inch.

(For the derivation of Lamé's formula, see Thurston's "Iron and Steel," page 452; Rankine's "Applied Mechanics," page 290, or Burr's "The Elasticity and Resistance of the Materials of Engineering," pages 19 and 895.)

If S is taken as the ultimate tensile strength of the material, the thickness found will be that which would just be ruptured by the given working pressure. To find the actual thickness the ultimate tensile strength must be divided by the factor of safety.

The accompanying set of curves has been devised to save the time and mathematical work involved in the solution of problems by Lamé's formula. By means of these curves any one of the four quantities may readily be determined when the other three are known.

To prepare the curves the formula was put in the form

$$\frac{R}{r} = \sqrt{\frac{S+P}{S-P}} \qquad (2)$$

in which

R = the external radius of cylinder.

r = the internal radius of cylinder.

(This is done by substituting r for $d/2$ and $R - r$ for t and then dividing by r.)

It will be seen that the value of the ratio R/r is independent of the diameter. For convenience, denote the value of this ratio by K. The formula then becomes

$$K = \sqrt{\frac{S+P}{S-P}} \quad (3)$$

The values of the inside diameter, d, are platted along $O\,X$ and values of the working pressure, P, are platted along $O\,X'$. Values of the ratio R/r are platted along $O\,Y$ beginning at unity instead of at zero. The values 100, 200, etc., are then substituted for S in (3) and the resulting curves between K and P are platted to the left of $O\,Y$. These curves represent stress in wall of cylinder.

Since $t = R - r$ and $R = Kr$, we have

$$t = Kr - r$$
$$= r\ (K - 1)$$

and therefore $2t = d\ (K - 1)$.

This equation is of the form $xy = C$. The values $\frac{1}{8}$, $\frac{1}{4}$, etc., are then substituted for t and the resulting curves between d and $(K - 1)$ are platted to the right of $O\,Y$. These curves represent thickness of wall.

The use of the curves may best be shown by a few examples.

Example 1: $d = 5$ inches, $S = 1{,}600$ pounds per square inch, $P = 700$ pounds per square inch; find t.

Solution—From point 700 in $O\,X'$ follow vertically upward to the stress curve marked 1,600, then horizontally to the right to the vertical line from point 5 in $O\,X$. The intersection falls nearly on thickness curve marked $1\frac{1}{2}$. The required thickness is therefore $1\frac{1}{2}$ inch.

Example 2: $t = 2$ inches, $d = 8$ inches, $P = 1{,}000$ pounds per square inch; find S.

Solution—From point 8 in $O\,X$ follow vertically upward to thickness curve marked 2, then horizontally to the left to the vertical line from point 1,000 in $O\,X'$. The intersection falls on stress curve marked 2,600. The required stress is therefore 2,600 pounds per square inch.

Example 3: $t = 1\frac{3}{4}$ inch, $S = 1{,}200$ pounds per square inch; $d = 8$ inches; find P.

Solution—From point 8 in $O\,X$ follow vertically upward to thickness curve marked $1\frac{3}{4}$, then horizontally to the left to the stress curve marked 1,200, then vertically downward to $O\,X'$, where we find the required stress, which is 420 pounds per square inch.

From (1) it will be seen that if t and d are both multiplied or both divided by the same number the values of S and P will not be affected, and likewise if S and P are both multiplied or both divided by the same number, the values of t and d will not be affected. By this means the use of the curves may be extended.

Example 4: $t = 4\frac{1}{2}$ inches, $d = 30$ inches, $P = 600$ pounds per square inch; find S.

Solution—Divide t and d by 3, giving $t = 1\frac{1}{2}$ and $d = 10$. Then, solving as in example (2), we find the required stress to be about 2,340 pounds per square inch.

Example 5: $d = 3\frac{1}{2}$ inches, $S = 5{,}000$ pounds per square inch, $P = 3{,}000$ pounds per square inch; find t.

Solution—Divide S and P by 2, giving $S = 2{,}500$ pounds per square inch and $P = 1{,}500$ pounds per square inch. Then, solving as in example (1) we find the required thickness to be $1\frac{3}{4}$ inch.

If a problem involves the use of the small rectangular space where the stress curves are not produced it may still be solved if S and P are multiplied by some number which will make P greater than 200 pounds per square inch.

* * *

THE DRAFTSMAN AND HIS WORK.*

Gentlemen—Your superintendent wanted me to come down to-night and give you a few words on the above subject. Now, if he could have reversed this operation and sent you boys all around to the shop instead of having me come here, I think we could have done the subject justice, for while I have the highest respect for the draftsman, I never could get accustomed to his environment. Many a time have I seen the foreman of the drafting-room gently place a sheet of blotting-paper beneath my elbow, when, absorbed in the problem we had before us, I have thoughtlessly placed it on his spotless sheet. But, as we should always make the best of the situation, we will try to do so in this case.

First, I wonder how many of you realize why you are here, or that in coming here you have taken the first step on the ladder that leads upward, for while thousands of men have passed through the shop into the drafting-room and beyond, seldom do we hear of a draftsman going back into the shop, except it be to supervise the work of others.

Perhaps I cannot do better than to give you a few illustrations of how the experience which a man gets in the drafting-room gives him the ability to get out of a cavity, when he is called upon to do so. The first is one that happened only a short time ago in this city:

They had just got a new smith; he was a good workman and could turn out a fair amount of work. One day the foreman took out a drawing of a piece of work for him to do. It was about three inches wide and ten feet long; too long to be shown the full length on the paper, so each end was drawn and the center broken in two with that jagged line we all know so well. The smith looked it over and said: "Well, I can make those ends all right, but who is going to cut in those saw teeth, me or the machinist?" Well, he didn't stay long, and as you can see, a little knowledge of drafting would have been worth dollars and cents to him at that time.

There is another friend of mine who goes down South, laying out plans for the big cotton mills; that is, he goes to the mill, takes the plans, and lays out the floor space for the machinery. He was down there on a job, miles away from any machine shop, and one night they came over from the other mill and told him of a scrape they had gotten into. They had ordered a piece of 6-inch shafting, 16 feet and 9 inches long, and by some error it had come 19 feet and 6 inches long. As it was intended to go down in the basement of the mill, it was not possible to use it on account of the extra 3 feet. Could he do anything for them? It was one hundred miles from any shop that could handle a shaft of that size. Jack thought it over a moment, thought what tools he had in his kit, and said: "Yes, I guess I can." Well, how long would it take? "Give me four good darkeys and you shall have it at seven o'clock in the morning—that is if you give me good men."

Well, Jack got his four men and he started in. He had a 12-inch saw frame in his kit and plenty of blades. First, he put a collar on the shaft, even with the place he wanted to cut off, and then he started in the first man and had him saw fifteen minutes, then changed him off for number two and so on. He let each man work fifteen minutes and lay off forty-five minutes. He kept it up in this way all night, and just as the whistle blew at seven the next morning the shaft was off. The mill superintendent was more than pleased, as his entire mill was shut down until the shaft was in place.

Another job that was done by this same man will, I think, interest you. Jack was sent out by a firm to put a large drum on a water-wheel shaft, 'way up in the Maine woods. It was miles away from anywhere. The drum had been bored out in the shop to fit a wire sent down from the mill, and he got the drum there and started it on to the shaft. It went all right to within about three feet of the place where it was wanted. There was a bunch on the shaft just where Jack didn't want it. What was to be done now? He started in with a file, but to take one thirty-second of an inch from a six-inch shaft is no joke, and Jack wanted to start back home that day. He took a four by four joist about ten feet long, stuffed it through the drum and blocked each end to prevent it from turning. He put a small rope fall at one end to pull the drum on with, and a chain fall at the other to prevent it going too fast, then, sprinkling the whole length of the shaft with oil and sand, he started the water wheel and ground away. It worked all right until he got within three inches of where it was wanted, and then the drum "seized" on the shaft, and brought the mill up, all standing. The keyway in the shaft and drum didn't line, but that didn't worry him any. He left the key with the

* Extract from an address before a body of draftsmen.

foreman and told him if the drum ever got loose he could put it in, but "if you ever want to take it off, don't send for me."

Your superintendent wanted me also to say a few words to you on dies and press tools. I spent a good deal of time in the Public Library of Boston and elsewhere, and found out a number of things that were interesting in that line, and while we must give the Germans credit for the origin of presses and dies, it was the French mechanics who were the ones to put them in practical every-day use.

In the year 1796 a patent was granted to one De Vere of France for press tools for both punching and drawing of sheet metal, and in 1827 patents were granted for the same class of work in this country. In 1859 two French workmen came to this country, bringing with them a wooden model of a drawing press. This had been made from drawings which they had surreptitiously taken from a press which they had been engaged in making. This press was stored in a barn at Wilmington, Delaware, and capital was obtained to form a company to build and operate the same, known as the Higgins & Marchand Company.

The press was a single-action cam press, the cam being used to force the drawing punch through the die; the blank being held down by a three thousand pound weight, which was worked by a sixteen-foot lever extending out through the wall of the shop, the weight being on the outside. The first piece of work drawn up was a wash-basin, and was made from a fourteen-inch blank. This was probably the first piece of drawn work ever made in America.

There is one thing that the draftsman invariably gets left on, and that is getting the length of the piece to be bent in the die. He always gets it too long. The rule usually followed is to take the center line of the stock; that is, if you have a piece of metal to bend, you allow one-half the thickness for every bend you make, and while this is all right in theory there is a certain amount of stretch beside this, and I never remember seeing a draftsman figure out a piece and get it too short. A safe way is to put a note on the drawing for the tool-maker to make the bending die first; it is the only safe way. I had the pleasure (?) some time ago of working up several tons of stock where they had made the blanking die first, and had gone ahead and blanked out the parts without waiting for the bending dies. It is needless to add that no drafting was done on the job, but it would have been money well spent if they had done so.

It is not necessary for me to say anything on the subject of drafting for tool work. A large manufacturer in this city, and one whom you all know well, said to me a few days ago: "I used to build all my tool work on the cut-and-try method, but now not a stroke of work is done until drawings are made, and I want the best man I can hire, too. It is a lot easier to change tools on paper than it is in hard steel."

One thing more and I will finish, and that is, whatever branch of drafting, or in fact anything else you take up, take up one thing and learn it thoroughly. It doesn't make any difference what that thing is; it may be brick machinery, sewing machine needles or steam turbines, or air ships; learn it well and you will always find a market for your goods.

J. L. Lucas.

* * *

INDEX SYSTEM

FOR DRAWING-ROOM IN SHOP WITH GREAT VARIETY OF WORK.

From time to time there have been published in Machinery articles concerning index systems for the drawing-room; being deeply interested in this subject myself I have read these articles with much care. However, the articles I have seen hitherto have related to drawing-rooms in shops where the product has been limited to only a few standard articles, which have been turned out in great quantities. Thus, not having been able to find an outline of a system that would suit the particular conditions under which I am working, I have been obliged to devise for myself a system specially adapted to a drawing-room in a shop with a great variety of work. As no doubt there are many of the readers of Machinery who have had trouble keeping in order the vast number of drawings, sketches, patterns and such tools as the drawing-room often is expected to keep track of, I have outlined below a system which I have devised and tried, and which I am at present using to good advantage.

At first glance the system might seem somewhat elaborate, but a little extra expense added in the beginning will more than repay itself in the long run. The main factor to be taken in consideration when planning a system is of course the rapidity with which a thing looked for can be found. The somewhat greater care needed to keep up a complete system will hardly amount to anything compared with the time wasted in trying to locate things looked for in an incomplete and patched up system.

The words, "drawing," "shop sketch" and "customer's sketch" referred to below are defined in this system thus:

1. *Drawing.*—Any tracing or drawing for machines, tools and devices manufactured by the firm as a standard article or used in the shop.

2. *Shop sketch.*—Any drawing, made in the drawing-room, of special tools that are ordered in small quantities by customers.

Customer's sketch.—Any drawing, tracing, sketch or blue print that has been sent to the firm by outside parties or customers.

Drawings are indexed on cards on which is stated—

1. Number and letter of drawing (the letter indicating the size of the drawing).
2. When made
3. By whom made.
4. By whom checked.
5. Complete title of the drawing.
6. Piece number (if a casting this is also the pattern number).
7. Remarks.

Drawing No. A-612 **Date** March 6 **1905**
Drawn by M. C-r **Checked by** Potter

Casting Detail:
Special head for #2
Brown & Sharpe Milling Machine.

Piece No. 656

Remarks: For construction see A-109.
For milling hexagon nuts.

Fig. 1. Index Card for Shop Drawing.

These cards are numbered, when they are blank, with the drawing numbers in rotation, and are kept in numerical order. As soon as a drawing is made the first blank card is filled out and its number stamped on the drawing. The card is then placed in the index according to the following rules: In the first place, tools and machines should be indexed in general classes, and all general attachments for the machines should be indexed under the heading of the machine with which they are used. For example, cutters of every description should be indexed under the word "Cutter," and subheadings should be provided in the index if the number of cutters of different descriptions make a sub-division necessary. Again, for example, "Dividing head for milling machine" should be indexed under "Milling Machine" and subdivisioned under "Head." Sketch No. 2 of an index arranged in this manner will make further explanations unnecessary.

Jigs and fixtures that are to be used for certain operations in manufacturing parts of standard machines and tools are indexed in the same divisions as the parts on which the operation is to be performed is indexed under, for example, the fixture for boring head for milling machine is indexed under "Head" for "Milling Machine." In cases where it is found difficult to decide under which heading to place a certain tool or fixture, it is advisable to make out two or even more cards under such headings where they are most likely to be looked for. The files for the cards should be kept in the

most accessible place in the drawing-room, where everybody having to use them can do so with convenience.

The drawings are filed in drawers in the drawing-room, but a "record blue-print" of each ought to be kept in a fireproof safe or vault; of course one must be very particular about replacing these "record blue-prints" every time a change is made on the original tracing or drawing.

Sketches, as a rule, being used only a very limited number of times, ought not to be traced but drawn either in copying ink or copying pencil, and copied in a special copybook used

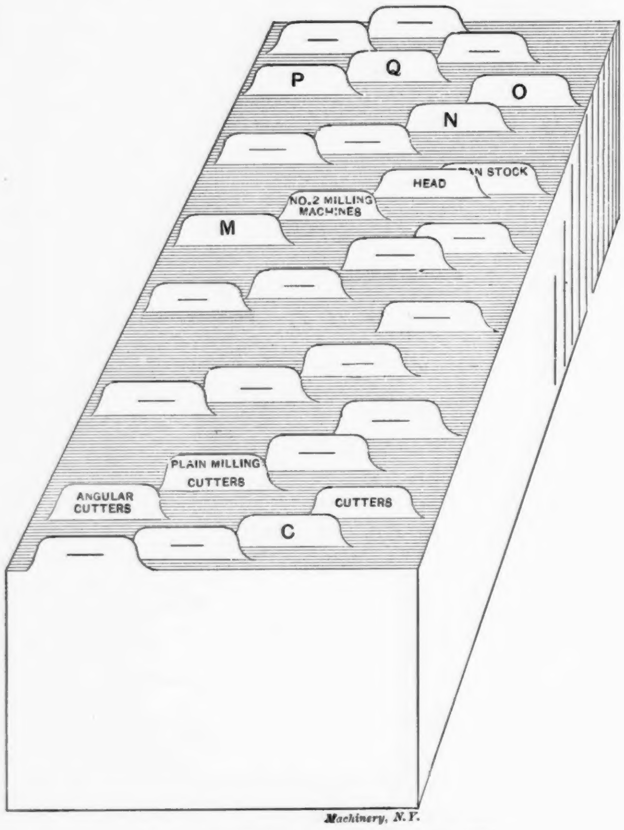


Fig. 2. Arrangment of Index Cards on File.

for the purpose. The sketch is marked with the page number of the copybook where it is copied. These sketches could of course be indexed on the index pages of the copybook, but when one copybook after another is filled out it would be a waste of time to have to go through the index of each one in order to find what is wanted; therefore a card index is provided for these sketches also where the cards are put in order according to the names of the customer.

No. of copybook 6 **Page** 314 **Date** March 12 1905
Drawn by G. R. **Checked by** Potter
Customer's name: American Tool Works Co., Cincinnati, Ohio.
Tool: Taper Reamer
Remarks: For Brass--made to their sketch.

There is also an additional card index for these sketches where the cards are put in order, not with reference to name of customer but according to name and kind of tool drawn on sketch.

Customer's sketches are not listed in any card index, but are kept in proper order in a common letter-file.

There is no need of providing for a card index for the patterns, as the pattern numbers are always marked, not only on the drawing itself but also on the index card for the drawing in question. However, it is both convenient and necessary in many cases to be able to tell from the number of the pattern what machine or tool this pattern applied to; therefore a book is provided with pattern numbers in rotation, where the patterns are entered as soon as a drawing is made.

It is not only necessary to keep a good record of drawings or patterns that have been made, but equally as important to have a complete record of blue-prints, sketches, patterns, etc., when in use. All blue-prints given out from the drawing-room must be charged to the person for whose use it is furnished, whether he be someone in the shop or an outside party. For this purpose there is a special set of cards, one card for each drawing, this card being provided with the drawing number; these cards are kept in numerical order. When a drawing is given out by the drawing room, the name

No. of Copybook 6 **Page** 314 **Date** March 12 1905
Drawn by G. R. **Checked by** Potter
Tool: Taper Reamer.
Customer's name: American Tool Works Co., Cincinnati, Ohio.
Remarks: For brass--made to their sketch.

of the person for whose use the drawing was given out is recorded on the card with the same number as the drawing. This enables anyone to find at a glance where every blueprint of a certain drawing can be found.

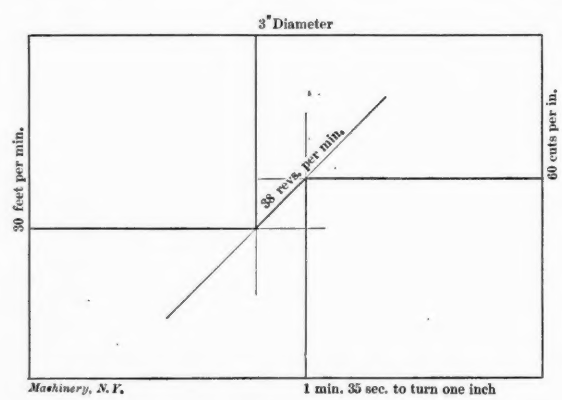
When sketches are sent out in shop, it is noted in the copybook itself on corresponding page, to whom and on what date, sketch was given out. As these sketches have to go from one department to another each department foreman is expected to keep a record of when and to whom he sent the sketch, when he was through with it. When the work is finished the sketch is returned to the drawing-room and the date when it was returned is noted down in the copybook on page number corresponding with sketch. Customer's sketches are never sent out in the shop, but are kept as records and for reference in the letter-file mentioned above.

A system laid out and made up in accordance with the principles above will prove itself very satisfactory, not to say necessary, for the drawing-room in a shop having a great variety of work to do. "A."

* * *

DIAGRAM FOR COMPUTING THE TIME TO TAKE LATHE CUTS.

On the opposite page will be found a diagram from which the time to take a given cut in the lathe may be estimated when the diameter of the work, the feed in turns per inch, and the surface speed or revoultions per minute are known. As shown in the cut below, follow the vertical line representing the desired diameter down to its intersection with the horizontal line which represents the desired surface speed;



follow the diagonal nearest this point, up or down, until it meets the horizontal line corresponding to the desired feed as read from the left of the table. A vertical line dropped from this intersection will show on the scale at the bottom the time it will take to turn one inch under the given conditions. This diagram was contributed by A. Thompson, of Birmingham, England.

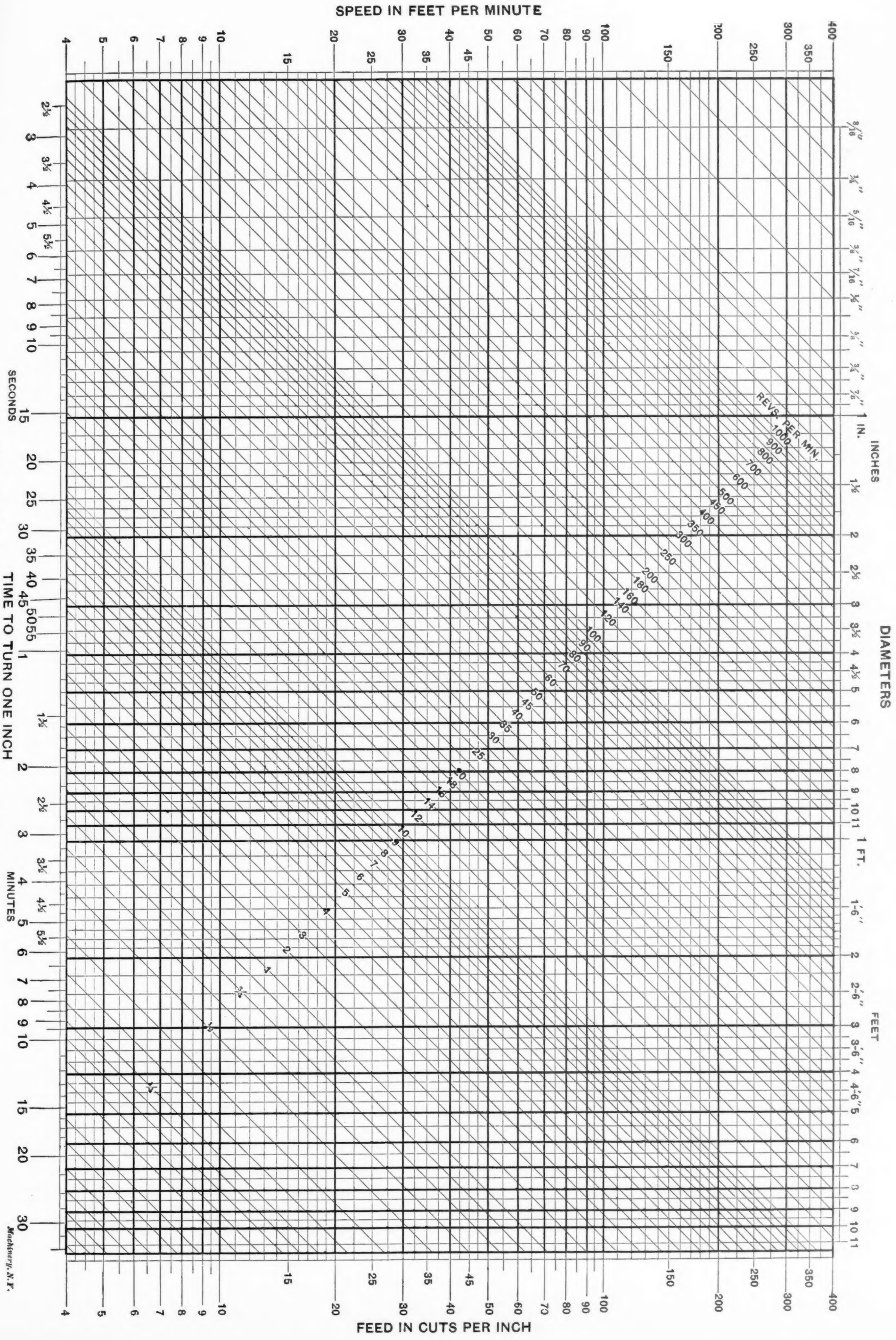


Diagram for Solution of Problems in Estimating Length of Time for Lathe Work.

BEVEL GEAR CHART.

GEORGE J. PORTER.

Some time ago I had occasion to lay out and find the necessary data for a pair of bevel gears where the shafts were not at right angles, and, as the formulas that I had at hand were only for cases where the shafts were at right angles, I looked through several standard treatises on gearing for something to help me out. Not finding anything, I worked out some formulas for myself to cover cases where the shafts were at less than right angles and greater than right angles. Since then I have prepared the accompanying chart and thinking that it might interest some of the many readers of MACHINERY, I send it to you.

Perhaps the best way of explaining the chart so that the reader may become familiar with it will be to work out an example in each of the three cases, using gears of the same pitch and number of teeth in each, so that a comparison of the results may be made and the differences of the face angles and outside diameters noted.

We will take for our examples gears of 12 and 18 teeth, 8 pitch and running with shaft axes at angles of 60 degrees, 90 degrees and 120 degrees respectively. Knowing the desired pitch and number of teeth, and, of course, the pitch diameter, the first thing to do is to find the center angles of the gears, and we will for convenience find that of the smaller gear first, and if we arrange our data as it is worked out, in some such form as that shown below perhaps it will help in making things clear.

Example 1: Shaft Angle, 60 degrees.

	Larger Gear.	Smaller Gear.
Pitch	8	8
Teeth	18	12
P. D.	2.25″	1.5
Center angle	36° 35′	23° 25′
Face angle	40° 22′	27° 12′
O. D.	2.451″	1.729″
No. of cutter	5	8

Example 2: Shaft Angle, 90 degrees.

	Larger Gear.	Smaller Gear.
Pitch	8	8
Teeth	18	12
P. D.	2.25″	1.5
Center angle	56° 19′	33° 41′
Face angle	61° 36′	38° 58′
O. D.	2.389″	1.708″
No. of cutter	4	7

Example 3: Shaft Angle, 120 degrees.

	Larger Gear.	Smaller Gear.
Pitch	8	8
Teeth	18	12
P. D.	2.25″	1.5
Center angle	79° 6′	40° 54′
Face angle	85° 20′	47° 8′
O. D.	2.297″	1.689″
No. of cutter	2	7

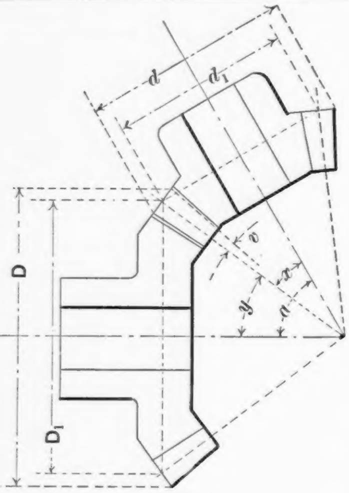


Fig. 1.

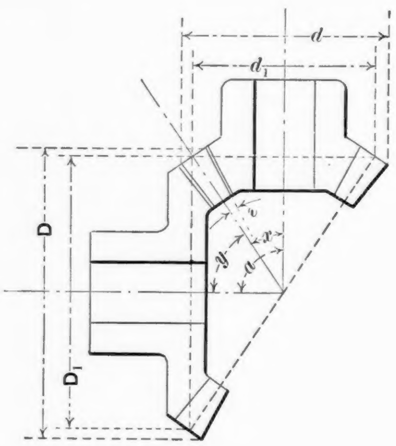
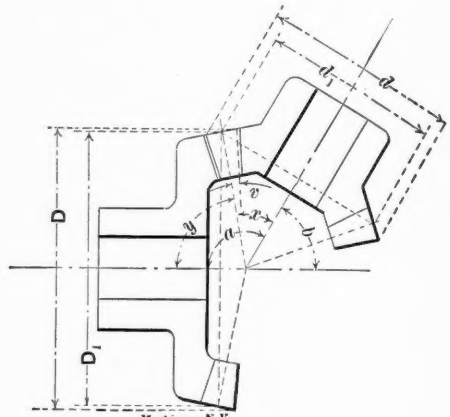


Fig. 2.



Machinery,N.Y.

Fig. 3.

Larger Gear.

D = outside diameter.

D_1 = pitch diameter.

y = center angle and also angle of back cone radius measured from line perpendicular to axis of gear.

R = pitch radius $= \dfrac{D_1}{2}$

N = number of teeth.

Smaller Gear.

d = outside diameter.

d_1 = pitch diameter.

x = center angle and also angle of back cone radius measured from line perpendicular to axis of gear.

r = pitch radius $= \dfrac{d_1}{2}$

n = number of teeth.

a = angle of shafts.

b = supplement of shaft angles $= 180° - a$.

D_2 = working depth of tooth.

v = angle increment.

Fig. 1.

When shafts are at less than right angles.

$$\tan x = \frac{r}{r \times \cot a + \dfrac{R}{\sin a}}$$

Fig. 2.

When shafts are at right angles

$$\tan x = \frac{n}{N}$$

Fig. 3.

When shafts are at more than right angles.

$$\tan x = \frac{r}{\dfrac{R}{\sin b} - r \times \cot b}$$

$$y = a - x$$

$$\tan v = \frac{\sin x}{\dfrac{n}{2}}$$

Face angle of larger gear $= y + v$.

Face angle of smaller gear $= x + v$.

$D = D_1 + (D_2 \times \cos y.)$

$d = d_1 + (D_2 \times \cos x.)$

Number of teeth to select cutter for larger gear $= \dfrac{N}{\cos y}$

Number of teeth to select cutter for smaller gear $= \dfrac{n}{\cos x}$

In the first example, referring to Fig. 1 on the chart, $r = 0.75$ inch, $a = 60°$; $R = 1.125$ inches, $\cot a = 0.57735$ and $\sin a = 0.86603$; now stating the formula,

$$\tan x = \frac{0.75}{0.75 \times 0.57735 + \dfrac{1.125}{0.86603}} =$$

$$\frac{0.75}{0.433 + 1.299} = \frac{0.75}{1.732} = 0.43303 = \tan 23° \ 25'.$$

Now referring to the chart, the center angle y of the larger gear $= a - x = 60° - 23° \ 25' = 36° \ 35'$.

The next thing we will find will be the angle increment, so that we may determine the face angles of the gears and we will find on the chart that the tangent of the angle increment

$$\text{or } v = \frac{\sin x}{\dfrac{n}{2}} = \frac{0.39741}{6} = 0.06623 = \tan 3° \ 47'.$$

The face angle of the larger gear $= y + v = 36° \ 35' +$

$3^\circ\ 47' = 40^\circ\ 22'$ and the face angle of the smaller gear $= 23^\circ\ 25' + 3^\circ\ 47' = 27^\circ\ 12'$.

Now for the outside diameters: For the larger gear the outside diameter, or $D = D_1 \times (D_2 \times \cos y) = 2.25 + (0.25 \times 0.80299) = 2.451$ inches.

For the smaller gear, the outside diameter, or $d = d_1 + (D_2 \times \cos x) = 1.5 + (0.25 \times 0.91764) = 1.729$ inch.

The number of teeth for which to select cutter for the larger gear $= \dfrac{18}{0.80299} = 22$. Therefore use No. 5 cutter.

The number of teeth to select cutter for the smaller gear $= \dfrac{12}{0.91764} = 13$; use No. 8 cutter.

Example 2: Tangent of center angle of smaller gear (see Fig. 2), or $\tan x = \dfrac{n}{N} = \dfrac{12}{18} = \dfrac{2}{3} = 0.66667 = \tan 33^\circ\ 41'$ —

Center angle of larger gear $= a - x = 90^\circ - 33^\circ\ 41' = 56^\circ\ 19'$

Tangent of angle increment, or $\tan v = \dfrac{\sin x}{\dfrac{n}{2}} = \dfrac{0.55460}{6} = 0.09243 = \tan.\ 5^\circ\ 17'$.

Face angle of larger gear $= y + v = 56^\circ\ 19' + 5^\circ\ 17' = 61^\circ\ 36'$.

Face angle of smaller gear $= x + v = 33^\circ\ 41' + 5^\circ\ 17' = 38^\circ\ 58'$.

Outside diameter of larger gear, or $D = D_1 + (D_2 \times \cos y) = 2.25 + (0.25 \times 0.5546) = 2.389$ inches.

Outside diameter of smaller gear, or $d = d_1 + (D_2 \times \cos x) = 1.5 + (0.25 \times 0.83212) = 1.708$ inch.

Number of teeth for which to select cutter for the larger gear $= \dfrac{N}{\cos y} = \dfrac{18}{0.5546} = 32$, hence use No. 4 cutter.

Number of teeth for which to select cutter for smaller gear $= \dfrac{n}{\cos x} = \dfrac{12}{0.83212} = 14$; use No. 7 cutter.

Example 3: Tangent of center angle of smaller gear (see Fig. 3), or

$$\tan x = \frac{r}{\dfrac{R}{\sin b} - r \times \operatorname{cotan} b} = \frac{0.75}{\dfrac{1.125}{0.866} - 0.75 \times 0.57735}$$

$$= \frac{0.75}{1.299 - 0.433} = \frac{0.75}{0.866} = 0.86605 = \tan 40^\circ\ 54'.$$

Center angle of larger gear $= a - x = 120^\circ - 40^\circ\ 54' = 79^\circ\ 6'$.

Tangent of angle increment, or

$$v = \frac{\sin x}{\dfrac{n}{2}} = \frac{0.65474}{6} = 0.10912 = \tan 6^\circ\ 14'.$$

Face angle of smaller gear $= x + v = 40^\circ\ 54' + 6^\circ\ 14' = 47^\circ\ 8'$.

Face angle of larger gear $= y + v = 79^\circ\ 6' + 6^\circ\ 14' = 85^\circ\ 20'$.

Outside diameter of larger gear or $D = D_1 + (D_2 \times \cos y) = 2.25 + (0.25 \times 0.18910) = 2.297$ inches.

Outside diameter of smaller gear or $d = d_1 + (D_2 \times \cos x) = 1.5 + (0.25 \times 0.75585) = 1.689$ inch.

Number of teeth for which to select cutter for larger gear $= \dfrac{N}{\cos y} = \dfrac{18}{0.18910} = 95$; hence use No. 2 cutter.

Number of teeth for which to select cutter for smaller gear $= \dfrac{n}{\cos x} = \dfrac{12}{0.75585} = 16$; use No. 7 cutter.

* * *

A six-inch Midvale case-hardened armor plate was recently tested at the Indian Head proving grounds with very satisfactory results, the penetration being less than two inches with a six-inch shell. The Midvale Company is said to have a secret process which is superior to the Krupp process controlled by the Carnegie and Bethlehem companies.

DRAFTING ROOM PRACTICE.

ROBERT GRIMSHAW.

I have read with interest the article by Mr. Ralph E. Flanders on drafting room practice, in your March issue, and would like to add something thereto.

In the first place, as to the drawing paper itself: When I spoiled paper in a ship works drawing office, we used "double elephant" size "egg shell" Whatman's paper mounted on linen, and expensive enough it was. The drawings were very often an infernal nuisance on account of their great size and the necessity for rolling them. The time spent on brush shading with India ink, sepia, and so on, and on fancy lettering would have paid for very many desirable changes in the drawing department. Now-a-days much of this sort of thing has been done away with but there is room for much improvement in just this particular. There are few establishments in which it would not be better, instead of a regular so-called drawing paper, to use either a good stout Manila paper on which the drawing is made in lead pencil and never inked in, or a semi-transparent stock upon which the original drawing can be made with India ink and afterward used without tracing for blueprinting. The use of Manila paper and lead pencils for original drawings is particularly to be recommended where, as in the automobile industry, every season is sure to bring some important changes, while orders for parts of each type are likely to come in for several years after the machines have left the works. From the original lead pencil drawings there may be made a good linen tracing which can be dated and from which blueprints may be taken, which, to all intents and purposes are the original drawings. Changes are easily made on such lead-pencil drawings, as the necessity for preserving the original lines no longer exists and new linen tracings may be made and marked with the second date. All the blue prints that are made therefrom bear this date and there can be no confusion; while the business of furnishing "repairs," which is usually most profitable, can go on without causing any uncertainty in the shop.

In marking the dimensions on drawings, especially for large work, the figures should be as far as possible either in feet all the way through, or in inches. If the two be used, the employment of the accent (′) for feet and the double accent (″) for inches should be avoided as a pestilence; not that one is likely to be in error as to whether the frame of an automobile is 13 feet or 13 inches long, but one can sometimes be in doubt as to whether a dimension is intended to be 11′ 8″ or 118″, especially where the whole of a piece is not indicated, but only the two ends are given.

A plain block or a simple italic letter is the best form to use. Architects have done much to spoil draftsmen in this particular. They often adopt a style of lettering so crazy as to be almost undecipherable. Underlining words has not, as draftsmen seem to think, the effect of making them more legible. "On the contrary, quite the reverse," as the Irishman said. Words are sometimes underlined in the text of books to give special emphasis to them or to attract the readers' attention, but this does not have the effect of rendering them more legible.

Marginal lines on drawings serve no useful purpose. They reduce the effective area of the sheet, for if one leaves a margin of one inch without indicating it by an actual line, one can draw clear up to the imaginary boundary. But if one fences off a margin by a real border, the lines of the drawing must be kept back from the fences at least half an inch. If the sheet of a detailed drawing is 9 x 12 inches and we leave a margin all round, we have already cut the available area to 65 per cent of the original size. If we still further reduce the area of the drawing itself by half an inch margin, we have only 77 per cent. of the former net area, or just one-half of the whole area of the sheet. A free one-half inch may be left for punch holes in which to insert patent binders which are so convenient for holding and keeping in place the various detail drawings of a set.

It is not sufficient just to "make" a drawing. After it is made, that is, after every line is drawn and all dimensions are entered thereon, the whole should be checked off with reference to every possible chance for error or improvement.

and this should preferably be undertaken by some one other than the draftsman who has done the work.

See that the parts are strong enough to do the work. See that they are of the proper materials and that all the dimensions are drawn to scale and check up with each other. Care should be taken that the proper number of pieces of each part for one machine, is called for on the drawing. The different parts should be so designed that the machining may be easily done with the facilities at the disposal of the establishment, and finish marks should be carefully checked to see that some parts are not marked to be finished which should be left rough, and *vice versa*. There should be, also, a correct list of the subsidiary but necessary articles to be drawn from the store house or ordered outside, as, for instance, oil cups, pet-cocks, and bolts.

Each part must be so designed that it may be readily removed for inspection or be easily accessible for cleaning and repairs. If the part is heavy, facilities should be provided for handling it, and some parts, such as cylinder heads, should have starting screws by which they can be given the preliminary lift from their seats. All moving parts should be furnished with lubricating devices so located that filling and cleaning may be easily attended to, and with oil passages so disposed that the lubricant will reach the surfaces for which it is intended without being frozen or dammed on the way. The different parts and dimensions of a machine wherever possible should conform to the standard in use in the country or shop to which they are to be sent. For instance, the standards of the Navy Department vary in some respects from those of the army, and this should be taken into consideration when doing work for either branch of the service.

Fig. 1. A "Pendulating" Electric Drill.

A very important point is the question of clearance for moving parts. Are all the intended movements possible, or will some moving piece strike some other moving or immovable one? This has happened twice within my knowledge: once where the connecting rods of a locomotive were made too short so that a complete rotation was impossible, and again where the crank of a pump engine could never have made a complete rotation if the mistake had not been discovered before patterns were made for the beds and housings.

If the drawing is not carefully examined and checked off in all these particulars, there is danger of some mistake of omission or commission, in making or assembling, which will cost money or cause delay or, perhaps, even endanger life.

A PENDULATING ELECTRIC DRILL.

DR. ALFRED GRADENWITZ.

The drilling of structural and similar work, where the pieces have to be bolted or riveted together, is fraught with special difficulties. It has so far mostly been the practice to drill each of the pieces to be joined separately, and when they are put together the holes do not fit accurately on each other and some after work is always necessary. Under such conditions the rivets do not completely fill the holes, and an objectionable strain is produced. If on the other hand the various parts are placed one above the other and drilled together, another drawback is experienced, since the lower parts are thrown aside by the boring pressure and shavings get into the joints, so that to remove these the pieces have to be dismounted.

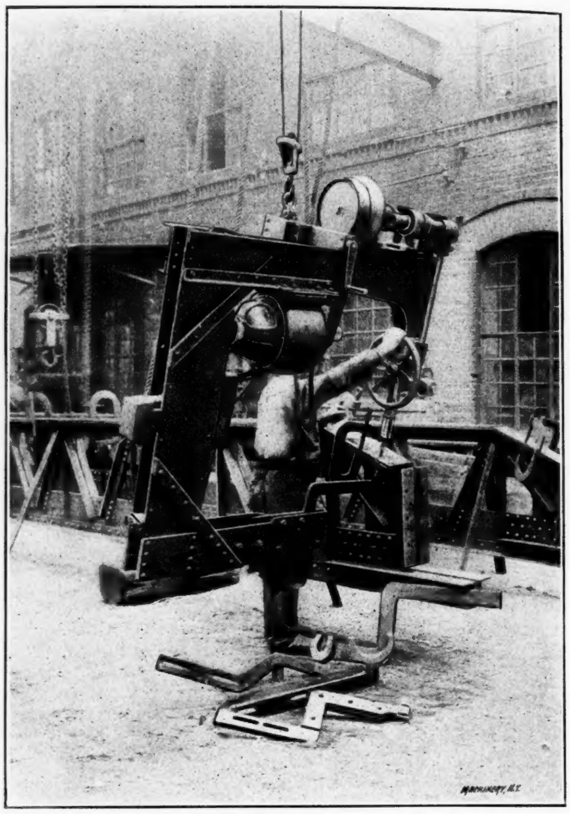


Fig. 2. Drill at Work on Angular Surface.

The pendulating electric drill just brought out by Karl Flohr, Berlin, is intended to obviate these drawbacks. It can be transported to the work, whatever the position of the latter, and the drilling is effected in a single operation. In fact, the arrangement of this drill in regard to the work is such that the pressure produced in drilling serves at the same time to compress the pieces and fit them together.

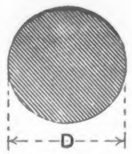
The arrangement and operation of this novel drill are illustrated in Figs. 1 and 2. It is supported by a traveling hoist by means of which it can be placed in a convenient position relative to the work.

The channel-shaped steel frame of the machine carries the drill spindle at one end, which is provided with power and hand feed, quick return, etc. An inverted closed motor bolted to the top of the frame drives the spindle through cone pulleys and belt transmission, and a pair of bevel gears. The lower part of the frame is so designed as to allow different braces being fitted to steady the frame, according to the shape to be drilled. Oblique as well as vertical holes can be drilled by changing the suspension point of the machine to one side or the other, as in Fig. 2, which causes the machine to hang in an oblique position. The machine can also be suspended so that horizontal holes may be drilled.

* * *

TABLE FOR COMPUTING HOLLOW AND SOLID SHAFTING

The table which is shown on page 21, contributed by R. R. Hillman, Buffalo, N. Y., will furnish a convenient means for comparing the relative strength and weights of solid and hollow shafting. It shows clearly the advantage of removing the core of the shaft, as is the common practice in marine engine work where lightness is necessary.

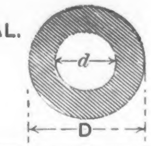


COMPARATIVE TORSIONAL STRENGTH AND WEIGHT OF HOLLOW AND SOLID SHAFTING, OF THE SAME MATERIAL.

UPPER FIGURES GIVE COMPARATIVE STRENGTH LOWER FIGURES GIVE COMPARATIVE WEIGHT

EXAMPLE:–A 25" HOLLOW SHAFT WITH A 10" AXIAL HOLE WILL WEIGH 16.00% LESS THAN A 25" SOLID SHAFT, BUT ITS TORSIONAL STRENGTH WILL BE ONLY 2.56% LESS.

$$\frac{H}{S} = \frac{D^4 - d^4}{D^4}$$



DIAMETER OF SHAFT D	DIAMETER OF AXIAL HOLE 4"	5"	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"	16"	17"	18"	19"	20"	21"	22"	23"	24"	25"	26"	27"	28"
6"	19.76 44.44	48.23 69.44																							
7"	10.67 32.66	26.04 51.02	53.98 73.49																						
8"	6.25 25.00	15.26 39.07	31.65 56.25	58.62 76.54																					
9"	3.91 19.75	9.53 30.87	19.76 44.44	36.60 60.49	62.43 79.00																				
10"	2.56 16.00	6.25 25.00	12.96 36.00	24.01 49.00	40.96 64.00	65.61 81.00																			
11"	1.75 13.22	4.28 20.66	8.86 29.74	16.40 40.48	27.98 52.89	44.82 66.92	68.30 82.63																		
12"	1.24 11.11	3.01 17.36	6.25 25.00	11.58 34.01	19.76 44.44	31.65 56.25	48.23 69.44	70.61 84.03																	
13"	0.87 9.46	2.19 14.80	4.54 21.30	8.41 29.00	14.35 37.87	23.00 47.90	35.02 59.17	51.27 71.61	72.61 85.22																
14"	0.67 8.16	1.63 12.76	3.38 18.36	6.25 25.00	10.67 32.66	17.68 41.33	26.04 51.02	38.12 61.75	53.98 73.49	74.35 86.23															
15"	0.51 7.11	1.24 11.11	2.56 16.00	4.75 21.77	8.09 28.45	12.96 36.00	19.76 44.44	28.93 53.79	40.96 64.00	56.42 75.11	75.89 87.10														
16"	0.40 6.25	0.96 9.77	1.98 14.06	3.68 19.14	6.25 25.00	10.02 31.64	15.26 39.07	22.34 47.28	31.65 56.25	43.58 66.02	58.62 76.56	77.25 87.90													
17"	0.31 5.54	0.74 8.65	1.56 12.45	2.89 16.95	4.91 22.15	7.86 28.03	11.99 34.61	17.53 41.89	24.83 49.85	34.20 58.49	46.00 67.83	60.62 77.87	78.47 88.59												
18"	0.25 4.94	0.70 7.72	1.24 11.11	2.29 15.12	3.91 19.75	6.25 25.00	9.53 30.87	13.87 37.36	19.76 44.44	27.20 52.16	36.60 60.49	48.23 69.44	62.43 79.00	79.57 89.31											
19"	0.20 4.43	0.50 6.93	1.00 9.97	1.85 13.57	3.15 17.73	5.04 22.44	7.68 27.70	11.24 33.53	15.92 39.90	21.92 46.82	29.48 54.29	38.85 62.33	50.29 70.91	64.09 80.04	80.56 89.75										
20"	0.16 4.00	0.40 6.25	0.81 8.10	1.51 12.25	2.56 16.00	4.11 20.25	6.25 25.00	9.16 30.26	12.96 36.00	17.86 42.25	24.01 49.00	31.65 56.25	40.96 64.00	52.21 72.23	65.61 81.00	81.46 90.24									
21"	0.14 3.62	0.33 5.67	0.67 8.16	1.24 11.11	2.11 14.51	3.38 18.37	5.15 22.67	7.54 27.44	10.67 32.66	14.69 38.32	19.76 44.44	26.04 51.02	33.70 58.04	42.95 65.51	53.98 73.49	67.01 81.85	82.28 90.70								
22"	0.11 3.30	0.27 5.17	0.55 7.43	1.03 10.12	1.75 13.22	2.81 16.73	4.27 20.66	6.25 25.00	8.86 29.76	12.13 34.92	16.40 40.48	21.62 46.48	27.98 52.89	35.66 59.69	44.82 66.94	55.64 74.58	68.31 82.64	83.03 91.11							
23"	0.10 3.02	0.23 4.73	0.47 6.80	0.86 9.26	1.47 12.10	2.35 15.31	3.58 18.90	5.24 22.88	7.41 27.22	10.21 31.94	13.73 37.05	18.10 42.53	23.42 48.39	29.85 54.61	37.52 61.24	46.57 68.23	57.18 75.61	69.50 83.36	83.72 91.49						
24"	0.09 2.77	0.19 4.34	0.40 6.25	0.73 8.50	1.24 11.11	1.98 14.06	3.02 17.36	4.42 21.01	6.25 25.00	8.61 29.34	11.58 34.02	15.26 39.06	19.76 44.44	25.18 50.16	31.65 56.25	39.23 62.67	48.23 69.44	58.62 76.56	70.61 84.02	84.35 91.84					
25"	0.07 2.56	0.16 4.00	0.34 5.76	0.62 7.84	1.05 10.24	1.68 12.96	2.56 16.00	3.78 19.36	5.29 23.04	7.32 27.04	9.84 31.36	12.96 36.00	16.78 40.95	21.39 46.23	26.88 51.92	33.37 57.84	40.96 64.00	49.79 70.56	59.97 77.44	71.64 84.48	84.94 92.16				
26"	0.06 2.36	0.14 3.70	0.29 5.32	0.59 7.24	0.90 9.47	1.45 11.98	2.19 14.79	3.21 17.90	4.54 21.30	6.25 25.00	8.41 28.99	11.08 33.28	14.35 37.87	18.28 42.74	23.98 47.93	28.52 53.40	35.02 59.17	42.56 65.24	51.27 71.60	61.24 78.26	72.61 85.21	85.49 92.45			
27"	0.06 2.19	0.12 3.43	0.25 4.93	0.48 6.72	0.78 8.78	1.24 11.11	1.89 13.72	2.74 16.60	3.91 19.75	5.57 23.18	7.23 26.88	9.53 30.87	12.34 35.11	15.72 39.63	19.76 44.44	24.53 49.51	30.11 54.86	36.60 60.49	44.08 66.39	52.66 72.56	62.43 79.00	73.51 85.73	85.99 92.72		
28"	0.05 2.04	0.11 3.19	0.22 4.59	0.40 6.25	0.67 8.16	1.07 10.33	1.63 12.76	2.39 15.44	3.38 18.36	4.65 21.55	6.25 25.00	8.24 28.70	10.67 32.66	13.59 36.85	17.08 41.33	21.21 46.04	26.04 51.02	31.65 56.25	38.12 61.75	45.53 67.47	53.98 73.49	63.56 79.72	74.35 86.23	86.47 92.98	
29"	0.04 1.90	0.09 2.97	0.19 4.28	0.33 5.82	0.58 7.61	0.93 9.63	1.42 11.89	2.07 14.39	2.94 17.12	4.04 20.09	5.44 23.30	7.16 26.75	9.27 30.43	11.81 34.35	14.85 38.52	18.43 42.92	22.63 47.56	27.50 52.43	33.13 57.55	39.57 62.90	46.91 68.49	55.23 74.31	64.62 80.37	75.14 86.68	86.91 93.21
30"	0.04 1.77	0.08 2.77	0.16 4.00	0.30 5.44	0.51 7.11	0.81 9.00	1.24 11.11	1.81 13.44	2.56 16.00	3.53 18.77	4.75 21.77	6.25 25.00	8.09 28.45	10.32 32.10	12.96 36.00	16.09 40.11	19.76 44.44	24.01 49.00	28.93 52.79	34.55 58.77	40.96 64.00	48.23 69.44	56.42 75.11	65.61 81.00	75.89 87.10
31"	0.03 1.66	0.07 2.60	0.15 3.74	0.26 5.09	0.45 6.66	0.72 8.43	1.09 10.40	1.59 12.59	2.25 14.99	3.10 17.58	4.16 20.39	5.49 23.41	7.10 26.63	9.05 30.06	11.37 33.71	14.12 37.56	17.33 41.62	21.06 45.89	25.37 50.36	30.31 55.05	35.93 59.93	42.30 65.03	49.49 70.34	57.55 75.86	66.56 81.58
32"	0.03 1.56	0.06 2.44	0.13 3.51	0.23 4.78	0.40 6.25	0.63 7.91	0.96 9.77	1.40 11.82	1.98 14.06	2.73 16.50	3.68 19.14	4.83 21.97	6.25 25.00	7.97 28.21	10.02 31.64	12.43 35.25	15.26 39.06	18.55 43.94	22.35 47.28	26.69 51.66	31.65 56.25	37.26 61.03	43.59 66.02	50.69 71.19	58.62 76.56
33"	0.03 1.46	0.06 2.29	0.11 3.30	0.21 4.49	0.35 5.87	0.56 7.43	0.85 9.18	1.24 11.11	1.75 13.22	2.41 15.52	3.24 17.99	4.27 20.66	5.53 23.50	7.05 26.53	8.86 29.76	10.99 33.14	13.50 36.72	16.40 40.48	19.76 44.44	23.60 48.57	27.98 52.89	32.94 57.39	38.54 62.07	44.82 66.94	51.83 71.98
34"	0.02 1.38	0.05 2.16	0.10 3.11	0.18 4.23	0.31 5.54	0.50 7.00	0.75 8.65	1.10 10.47	1.56 12.45	2.14 14.62	2.88 16.95	3.79 19.46	4.91 22.15	6.25 25.00	7.86 28.03	9.76 31.22	11.98 34.61	14.56 38.15	17.53 41.89	20.96 45.76	24.83 49.85	29.24 54.06	34.20 58.49	39.77 63.06	46.00 67.83
35"	0.02 1.30	0.05 2.04	0.09 2.93	0.16 2.93	0.28 5.22	0.44 6.61	0.67 8.16	0.98 9.88	1.39 11.75	1.91 13.79	2.56 16.00	3.38 18.36	4.37 20.89	5.57 23.58	7.00 26.44	8.69 29.46	10.67 32.66	12.96 36.00	15.62 39.51	18.65 43.18	22.11 47.02	26.04 51.02	30.46 55.18	35.42 59.51	40.96 64.00

Machinery, N.Y.

RELATIVE SPACE OCCUPIED BY TURBINES AND ENGINES.

Diagrams have occasionally been published showing the relative floor area and head room required for steam turbines and reciprocating engines, but comparisons have usually been made between units of large power, the engines being of the slow-speed type, and consequently large and massive for the work they have to do.

We show on this and the opposite page, several diagrams of this nature, but they are a little fairer to the steam engine than usual, because the engines taken for comparison with the turbines are of high or medium speed. Inasmuch as turbines are high-speed machines, it is only just to contrast them with engines designed to run at moderately high speeds. Even with this advantage, however, it will be evident from the diagrams that a power unit, consisting of an engine and generator, occupies very much more space than a turbine and generator. A considerable part of this additional space is required for the generator and flywheel, the former of which is much more bulky in the case of the engine than with the turbine outfit, and the latter, of course, is not required at all with the turbine.

In these general views we have shown only the engines, or turbines, and generators, and have not included the condenser and auxiliary apparatus. Inasmuch as the turbine should operate at a higher vacuum than the steam engine, much larger condensers and larger auxiliary apparatus are required, so that the relative space occupied in a power plant by an engine outfit and a turbine outfit complete, does not show so great a discrepancy as would be inferred from the drawings here shown. We intend in a future number to publish several diagrams indicating the space

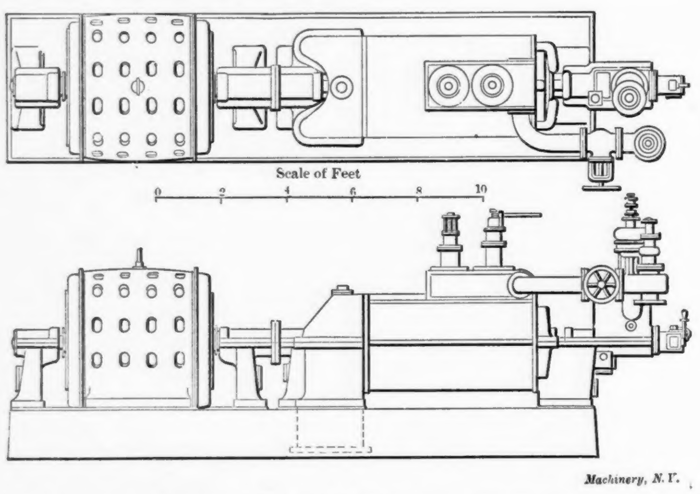


Fig. 2. Plan and Elevation of 500 K.W. Westinghouse-Parsons Steam Turbine.

required for turbines and their condensing outfits, by the aid of which a fairer estimate of the floor space necessary for a complete generating outfit can be made.

All of the drawings shown in this connection are to the same scale and probably the case made out is as good a one for the steam engine as is possible.

In Fig. 1 are a plan and elevation of a McEwen tandem compound high-speed engine, having cylinders 21 and 36 x 24. This type of engine is probably the most compact of any of the horizontal engines. The machine from which the diagram of Fig. 1 was taken was designed to be direct-connected to a 400-kilowatt alternating-current generator, and to run non-condensing. If run condensing, however, it would be ample to drive a 500-kilowatt generator, and the Ridgway Dynamo & Engine Co., who are the builders, inform us that if connected to a 500-kilowatt Thompson-Ryan direct-current generator, which they build, the space occupied by the latter would be no greater than the space required for the 400-kilowatt alternating-current machine. The plan view in Fig. 1 shows the top of the foundation, which is about six inches larger all around than the base of the engine bed. The foundation is also shown for the generator and outboard bearing.

In Fig. 2 are a plan and elevation of a Westinghouse-Parsons steam turbine, direct-connected to a 500-kilowatt generator.

In Fig. 5, on the opposite page, is another horizontal engine, which may fairly be compared with the horizontal type of turbine. This engine is of Rice & Sargent design, built by the Providence Engineering Works, and has cylinders 18 and 36x32. It is direct-connected to a 500-kilowatt generator, and as the engine has a stroke of only 32 inches it is intended to run at a moderately high speed, for the Corliss type of engine. This machine, it will be noted, is a cross-compound engine,

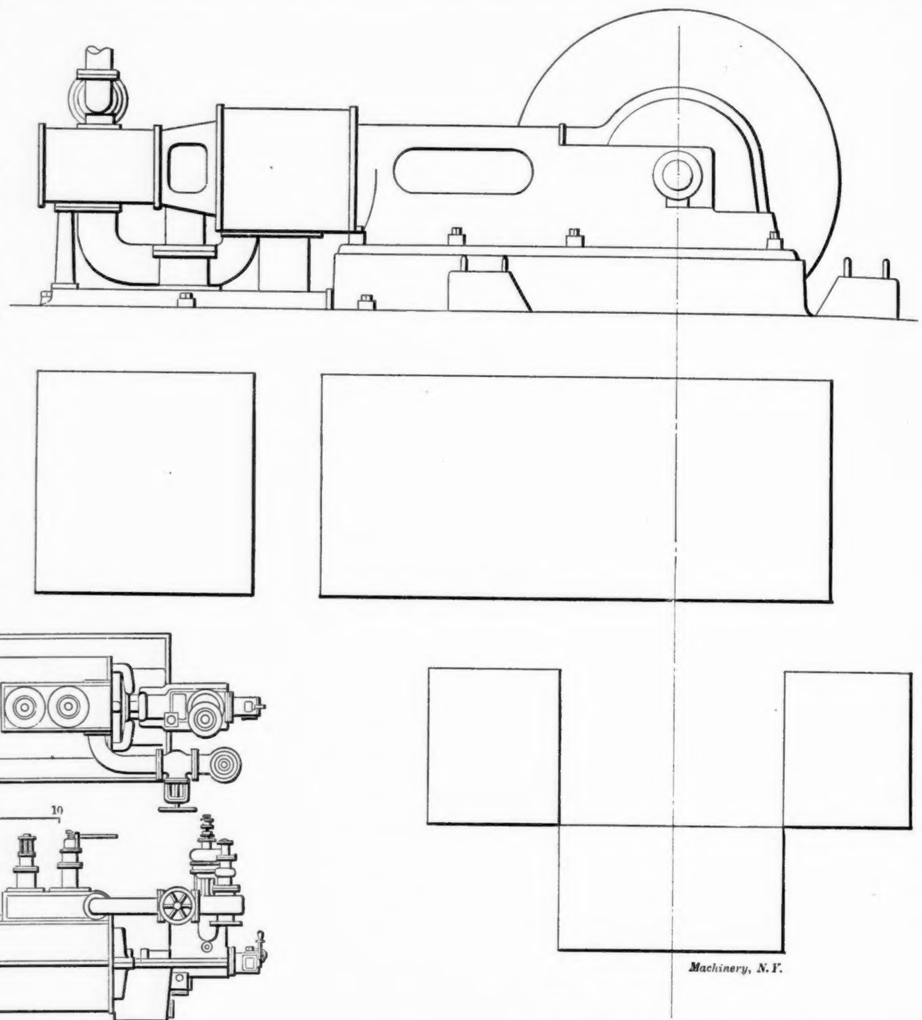


Fig. 1. Elevation of McEwen Tandem-compound High-speed Engine suitable for Connecting to 500 K. W. Generator, together with Foundation Plan.

and consequently occupies relatively more space than the tandem engine of Fig. 1.

In Fig. 3 is illustrated a cross-compound vertical engine, driving a 500-kilowatt generator, and for comparison with it is a vertical Curtis turbine of the same capacity, in Fig. 4. The diagram of Fig. 3 engine represents one of the medium-speed engines built by the Shepherd Engineering Co. This company also manufacture a vertical high-speed engine of the same power, which runs at 225 revolutions a minute. The area occupied by this latter machine, including its generator and outboard pedestal, which supports the outer end of the generator shaft, is about 9 feet by 22 feet. The area occupied by the medium-speed engine, exclusive of the extra width necessary to accommodate the large flywheel and generator, measures about 8½ by 19 feet; but with the above width added, the total space would be a little greater than for the high-speed machine, which has a smaller flywheel and generator. The heights of the two engines are practically the same.

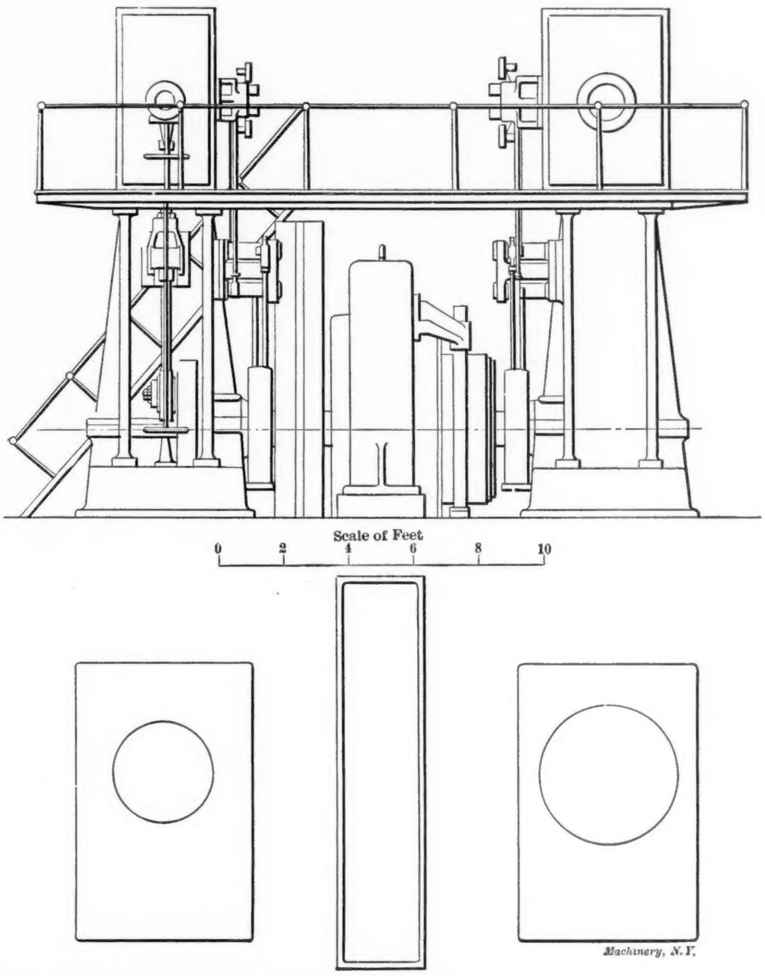


Fig. 3. Plan and Elevation of Medium Speed Compound Vertical Engine Direct-connected to 500 K.W. Generator.

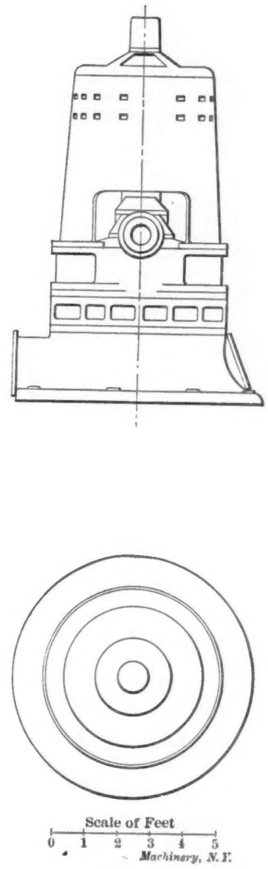


Fig. 4. Plan and Elevation of 500 K.W. Curtis' Turbine and Generator.

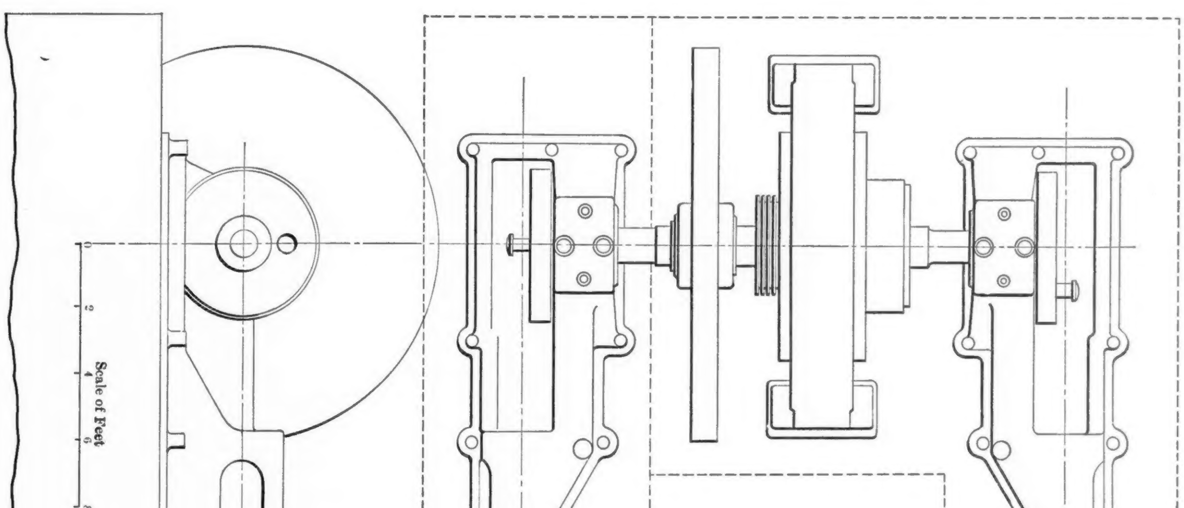


Fig. 5. Plan and Elevation of Medium Speed Corliss Engine Direct-connected to 500 K.W. Generator.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

This number marks the beginning of the twelfth volume of MACHINERY. The index for the eleventh volume is now ready, and one will be sent to any subscriber asking for it. In writing state whether an index is desired for the Engineering or Shop Edition.

* * *

We have previously announced that the September number would be a "draftsmen's number," which accounts for the fact that the most of the space in the current issue is devoted to articles of value, mainly to draftsmen and machine designers. The data sheet supplied with the Engineering Edition is double the size ordinarily furnished and contains the most complete and accurate set of formulas upon loaded beams that has ever been prepared. Dr. Sanford A. Moss, the author of these, has had long training and experience in mathematical work connected with engineering and physical problems, and has calculated his formulas from "first principles," not depending upon equations given in textbooks or elsewhere. The proofreading of this data sheet has been done with extraordinary care and we believe the result to be a nearly perfect table—we do not dare say a perfect one.

* * *

THE GEARED DRIVE.

From the present trend in machine-tool design it is probable that the geared, variable-speed drive will be adopted by manufacturers of nearly all types of tools to a greater or less extent. It is not to be expected that this form of drive will supersede the belt and cone, but it will undoubtedly displace the older form on many machines designed for high-speed steels.

Whether this tendency is a fad remains to be seen. The inflexibility and large number of parts that are characteristic of an all-gear head invariably lead to occasional breakages. It is doubted by many whether, after all, the advantages to be derived from such a construction are sufficient to offset the flexibility and simplicity of the old-fashioned belt drive.

Several years ago, when the multiple-voltage direct-current system of electrical transmission was being introduced, some designers of machine tools predicted that it would be superseded by constant-speed motors combined with variable-speed gear drives for machine tools, because this arrangement would be simpler than the multiple voltage system and its complicated wiring, its equalizer, etc.

Since that time, however, variable speed motors operated by field control or other means, more simple than the multiple voltage system, have come into use, but along with these systems mechanical variable-speed arrangements have also been developed by machine tool builders as a part of the machines themselves, so that the purchaser of machine tools has a wide latitude in choosing the kind of drive that he prefers. We should like to hear from readers who have had experience with different systems of speed control—especially mechanical devices. The subject is worth more attention than it has received.

* * *

INDENTURED APPRENTICES.

The Deane division of the International Steam Pump company are to resume the indentured apprentice system that has been out of vogue among the mechanical and machine plants of the country for quite a number of years, but which has been revived among them the last two or three years to quite an extent. There is a decided lack of expert machinists such as it is believed are only or at least best produced under the indentured system, by which a young man under 21 is bound for four years, and 21 or over for three years to the company to learn the business thoroughly. By its terms the young men receive five cents an hour at first, increasing each six months, and at the end of the apprenticeship are paid a bonus of $100. They are then supposed to be and in most cases are able to earn the wages of a fully equipped machinist, which range from $2.25 a day upward, according to the work, the shop, and the skill of the machinist. Years ago the Deane company used to do the same thing, but has not for a number of years; and in now taking it up it is doing what many large shops have deemed it advisable to do.—*Springfield Mass., Republican.*

This press item correctly outlines the conditions that many manufacturers are finding themselves up against. It is inevitable that any system for training employees which is as superficial, incomplete and as loosely conducted as the modern plan of breaking in "hands" must eventually fall to the ground. It is very true that "all round" machinists are not required to anything like the extent, relative to the total number of men employed, that they were a few years ago, though there are few shops where good machinists are not appreciated, and needed, also, for more or less of the work that is done. But beyond all this, it must be recognized that men are wanted, whatever the kind of work, who are able to use good judgment, and who are reliable.

How are we getting these men? Under the present manufacturing conditions it is thought advisable to employ operatives, instead of machinists, who, by a few months' experience, learn to do one thing rapidly and to turn out a large quantity of work at a low cost of production. Employers do not want to bother with the instruction of apprentices in several lines of work, and boys, on their part, who can see the prospect of earning $2.00 a day by piecework, within a comparatively short space of time, by becoming proficient hands, do not want to spend the four years necessary to learn the trade, during which time they would have to work for small wages. The consequence is that we are not making reliable and efficient workmen. There is no short cut to this end any more than to any other object worth striving for. A bright boy may learn the main facts about an engine lathe in six days, but it will require six months to learn to use his calipers, or to have good judgment about his speeds and feeds.

It is hard for a boy to appreciate the value of long training on these different machine shop operations and it is the common experience of employers that apprentices will leave before completing their full course and hire out as competent hands, or even as journeymen, unless they are under bond to spend their full time under instruction. This is why the indentured system is to be desired. It is better for the boy and better for his employer. Along with it should go a disposition on the part of the employer to give the boy a square chance, even at some inconvenience. The apprentice works at low wages, and it is generally conceded that he is able to make good, even if shifted around considerably. If he is unable to make good it is pretty certain that he ought to do something else for a living.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH

The monthly bulletin of the Fidelity and Casualty Company reports a flywheel accident at Memphis, Tenn., which is thought to have been caused by a loosening of the pillow-block. All circumstances of the accident indicate that the pillow-block gave way and that the wheel was broken by being brought in contact with the side walls of the wheel-pit. The entire engine was wrecked, being reduced to a condition worthless except for junk.

The use of plaster of paris is frequently hampered by the fact that it sets very quickly after being mixed. It is often desirable to use it in places where large quantities should be mixed at one time, but its quick-setting quality makes very rapid work necessary. A correspondent of the *Pattern Maker* says that if one part lime is mixed with five parts plaster of paris the mixture will set slowly but will harden just as well eventually as the pure plaster of paris.

The Chinese Government, according to German papers, has granted its first patent. It is for an electric lamp, the inventor of which is an inhabitant of Nankin, the old capital of the Chinese Empire, who calls his lamp the "bright moonlight," and asserts that it is far superior to foreign glow lights that hitherto have been sold at Shanghai and other Chinese cities. The fact that China has entered upon the granting of letters patent is undoubtedly of more importance than the invention.—*Consular Report.*

An illustration of the error of some common impressions is shown in what has been found to be the best and safest construction for windmill towers. The not unnatural idea that a windmill tower screened by large buildings or trees, or behind a hill would be less likely to be overturned by windstorms than if in the open, was found many years ago to be erroneous. The safest place for a windmill tower is on a spot where the wind can strike it fairly from every direction. In such a location the veering, shifting currents are less pronounced than behind buildings or hills, and there is also less of a lifting force to the wind in the open than behind obstructions.

Nickel vanadium steel has been made containing 0.141 per cent carbon, 0.512 per cent manganese, 9.36 per cent nickel, and 0.29 per cent vanadium, which showed a tensile strength of 101.2 tons per square inch. The best previous record for nickel steel was 88.8 tons. The tensile strength of mild steel contining 0.25 per cent carbon and 0.40 per cent manganese was raised from 30 tons to 47 tons per square inch by the addition of 0.25 per cent vanadium. As a result of the tests, Prof. Arnold said that it demonstrated beyond a doubt that the addition of a few tenths per cent of vanadium raises the elastic limit of mild construction steel at least 50 per cent without seriously impairing its ductility.

According to a newspaper item, the lifting magnets, which we have described in the columns of MACHINERY, are useful for other purposes than that of lifting masses of iron and steel. It appears that a gambling business is being done on a steamer anchored in Lake Michigan, opposite Chicago, racing news being conveyed between it and the shore by means of wireless telegraphy. The wireless telegraph works all right except when the lifting magnets used by the Illinois Steel Company at the mouth of the Calumet River are in operation, and then the wireless telegraph goes out of business. The work of loading steel plates begins at two o'clock and continues until six.' During this period it is alleged that it is impossible to transmit wireless messages.

The general report to the London Board of Trade on railway accidents in 1904, issued on July 17, states that the danger of railway traveling has been reduced to such a point that in 1904 the chances against a passenger being killed in a train accident in the course of a given journey were more than 200,000,000 to 1. The risks incurred by railway servants, especially those concerned with the movement of traffic, are of course much greater. In their case there is an element of danger which cannot be eliminated, though its effect may be minimized by the adoption of suitable appliances and safeguards. The increasing use of such appliances is having an appreciable effect, but it is claimed that the carelessness engendered by familiarity with dangerous conditions appears to be responsible for so many accidents that it is unreasonable to expect any marked reduction in the total number of accidents to railroad servants.

The Mining Reporter says that in the quest for gold every known invention and discovery of science is made to contribute its share toward reducing the difficulties of the search by increasing the facilities for travel. It is still within the memory of a few pioneers when ox teams were the only means of transportation for crossing the plains to the gold mines. From ox teams in the '60s to automobiles traversing the Nevada deserts in the twentieth century is a far cry, but it is only indicative of the rapid progress of modern times. Twelve automobiles are now in operation between Las Vegas, Bullfrog and Goldfield, and this new method of transportation in the mining industry is considered a notable innovation. The new line, which is operated in two divisions, is taxed to its utmost capacity. The first division is from Las Vegas to Bullfrog, a distance of 124 miles. This run is made in 14 hours and the fare is $40 per passenger. On the second division, from Bullfrog to Goldfield, a distance of 70 miles, the company makes a charge of $25 per passenger.

When a chunk of cold cast iron is thrown into a ladle of liquid iron, it immediately sinks because it is heavier than the molten iron. But, says the *Ironmonger*, in a moment or two the iron, still solid, but white hot, will rise and float upon the surface, which is proof that it has expanded more than the molten iron and is consequently lighter. The piece will become rapidly smaller and sink below the surface as the last portion melts, which proves that at melting it is not as light as when it floated on the surface. The converse of this action is that molten iron shrinks as it cools until crystallization takes place, when it slightly expands, the amount of final shrinking depending upon the difference between the total shrinkage and the expansion caused by crystallization. In an inch test bar cooled in the mold the greatest expansion is reached in about fifteen minutes after the mold is filled, but a larger bar, say four inches square, does not stop expanding for one and a half hours, and it is for this reason that the final shrinkage of a large casting is less than of a smaller one.

At the recent meeting of the N. E. Cotton Manufacturers' Association Mr. George I. Rockwood thus expressed himself regarding boiler draft production:

"By means of a fan a smaller installation of boilers will do the work of supplying sudden demands of dye-house or bleachery for gusts of steam for an hour or two, than would otherwise be required. This is much the more economical scheme as compared with the large reservoir of hot water idea, embodied in a much larger boiler plant than the fan would make necessary and working the greater part of the day very lazily under a light chimney draft, simply to be there when the heavy demands for steam come. It is not, apparently, generally realized that a stoker grate is more durable under a heavy fire than under a light one; and sudden changes from heavy fires to light ones cause the grate to burn out very fast. Again, a mechanical draft system, costing $5,000 installed, will do the work of sixteen 220-horse-power boilers with twelve, the sixteen having only a 175-foot stack. Each boiler with its full equipment and building costs about $8,000. The difference between sixteen and twelve is four boilers saved, or $32,000. Thus there can be no question as to the desirability of providing both chimney and fan in this class of boiler plants; and the same thing has been found true in large electric power plants."

Aluminum paper is now manufactured in Germany and recommended as a substitute for tin foil, says Consul-General Guenther, of Frankfort, Germany. It is not the so-called leaf-aluminum, but real paper coated with powdered aluminum, and is said to possess very favorable qualities for preserving articles of food, for which it is used as a covering. Chemical analysis has proven that aluminum paper contains but few foreign substances; occasionally it may contain up to 2 per cent. of iron, but never any arsenic or other poisonous metals. Hence it appears that the powdered aluminum used for the manufacture of aluminum paper is relatively pure. The paper used is a sort of artificial parchment, obtained through the action of sulphuric acid upon ordinary paper. The sheets are spread out and covered upon one side with a thin coating of a solution of resin in alcohol or ether. Evaporation is precipitated through a current of air and the paper is then warmed until the resin has again become soft. Then powdered aluminum is sprinkled upon it and the paper subjected to strong pressure to fasten the powder thereon. The metallic covering so obtained is neither affected by the air nor by fatty substances. Aluminum paper is much cheaper than tin foil and will, so it is thought here, become a strong competitor thereof.

The use of wind as a motive power is declining in European countries, according to the *Mechanical Engineer*. The mills for grinding corn operated by wind are not in a prosperous condition and few of them grind wheat into flour, being mostly confined to crushing grain for cattle. Many of the mills which formerly depended entirely on wind as a motive power have installed auxiliary power in the shape of oil or steam engines. The present-day farmer is too busy to wait, as previously, until the wind is favorable for grinding, but requires his corn ground at once. As between the mill dependent upon the wind and the one having an engine, the latter will receive the most of the business in that vicinity. In short, modern conditions demand that motive forces shall be amenable to the requirements of the users, and that they shall not be at the mercy of the weather. That wind power may be utilized in great quantities is possible, but it will have to be done under entirely different conditions than are now feasible with the present apparatus. The difficulty of using the power of the winds is in kind similar to that of getting power from the ocean's tides and waves; the cost of the apparatus is so great as compared to the power obtained that the interest on the capitalization becomes ruinous. It would appear that, if wind and wave power be used largely in the future, our descendants will have to devise ways for obtaining such power by other than mere physical means.

Mr. Alex. Del Mar contributes to the July *Engineering Magazine* an enthusiastic article on the gold dredges and the effect they are to have in the social and economical developments of the future. He says: "The world is not only to be saturated with gold; it is going to be nauseated. These gold ships will sail all over the vast areas of low grade auriferous soil throughout the world, which are at present unworked, and discharge their precious cargoes into the mints. The gold ship is a dredge which floats in a pond of its own making, a pond which accompanies it wherever it chooses to go, and which enables it to move over the land in any direction; thus imbued with volition it advances to the point of attack, scoopes up the gravel, subjects it on its decks to the action of riffles, undercurrents and amalgamation—indeed to any desired process, whether mechanical or chemical, and then having exhausted it of its gold, casts gravel behind and keeps on advancing until the field before it is sifted and treated from surface to bedrock.

"These dredges cost from $35,000 to $50,000 each, according to size. The present rate of outturn is about one machine per week; in the course of a few years it will be one per diem; in ten years it will probably be ten machines per diem. When this takes place, and perhaps before it, the world's production of gold, even should the quartz mines yield no more than at present, will be two million dollars a day.

"When, during the sixteenth century, the mines of America threw upon the world a vast and unlooked for supply of the precious metals, the result was to impart a sudden and tremendous stimulus to production, invention and discovery. The Halcyon ages dawned; and Europe rose at a bound from penury, ignorance and retrogression, to comfort, enlightenment and progress. That such may be the bright future before us of to-day, nothing seems wanting but to let the Gold Ships pursue their eventful voyages in peace."

What is undoubtedly one of the most remarkable mineral deposits in the United States, if not the most remarkable, is the sulphur bed in Calcasieu Parish, Louisiana. For many years it has been known that a large tract of land in this locality was underlaid by a sulphur bed of unknown depth, 500 or 600 feet below the surface. Boring tools have penetrated the sulphur deposit to a depth of 200 feet and how much deeper it is, is not generally known, although it may be known to those who are at present engaged in working the deposits. Because of the character of the soil (quicksand) which overlays the sulphur deposit, many schemes were tried unsuccessfully for working it, until a Western engineer conceived the idea of sinking a bore hole into the sulphur and softening it with steam pressure so that it could be forced out by powerful pumps. This scheme worked successfully, and the plant now in operation has a capacity of something over 200 tons daily. The sulphur is allowed to flow from each discharge pipe into an open vat, constructed on the ground and there it is allowed to harden in a layer about 18 inches thick. After hardening the sulphur is broken up and shipped in bulk in car-load lots. It is believed that the business is controlled by the Standard Oil interests operating under the name of the Union Sulphur Company. The sulphur obtained is so pure that it is used without refining for a great variety of commercial purposes. When it is considered that the sulphur deposit in this place is practically inexhaustible and that it can be mined at a trifling expense, it is quite probable that sulphur will enter very largely into the arts where heretofore its use has been limited on account of cost, although as yet the price is fixed at $15 to $20 per ton. It is said that the company will soon be in a position to produce something like a million dollars worth of sulphur a year.

The actual volumetric capacity of a given fan, operating under practical conditions, is naturally to be sought as a means of measuring it relatively to any other fan. But manifestly such capacity is somewhat difficult of pre-determination. In the case of a steam engine, its normal rating—that by which one engine may be measured relatively to another—is based upon the diameter, and stroke of the cylinder, the number of revolutions and the mean effective pressure. But the power thus calculated by no means represents the amount which may be delivered to a given machine, for the sole purpose of operating which the engine is employed. This latter amount will be less than that calculated, to the extent that power is absorbed in the internal friction of the engine and by the intermediate mechanism of transmission. So in the case of a fan wheel, its theoretical volumetric capacity will depend upon its dimensions and the speed at which it is operated. But in practice the actual amount of air delivered will also be largely dependent upon the fact of the wheel being encased, the character and dimensions of the case, and the size and resistance of the passages through which the air is conducted. The equivalent of such resistance is in boiler practice usually represented by the grates, the fuel, tubes, etc., and may evidently be so great at times as to very seriously reduce the theoretical air discharge of the fan.

Evidently, it is improper to compare fans when operating under such conditions that these resistances cannot be definitely determined. The simplest and most natural condition is that in which the fan is operated without other resistance than that of the case; that is, with open inlet and outlet. But for proper comparison of different fans, the areas through which the air is discharged should bear some constant relation to the dimensions of the wheels themselves.

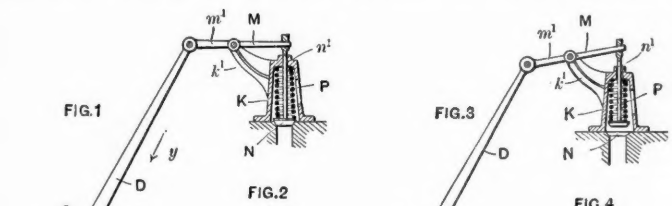
It has been determined experimentally that a peripheral dis-

charge fan, if enclosed in a case, has the ability, if driven to a certain speed, to maintain the pressure corresponding to its tip velocity over an effective area which is usually denominated the "square inches of blast." This area is the limit of its capacity to maintain the given pressure. If it be increased the pressure will be reduced, but if decreased the pressure will remain the same. As fan housings are usually constructed, this area is considerably less than that of either the regular inlet or outlet. It, therefore, becomes necessary, in comparing fans upon this basis, to provide either the inlet or the outlet with a special temporary orifice of the requisite area and proper shape, and to make proper correction for the contracted vein. The fan is thus, in a sense, placed in a condition of restriction of discharge, which it approaches in practice only in so far as the resistance of pipes, passages and material through which the air must pass has the effect of reducing the free inlet or outlet of the fan.—*Extract from treatise on Mechanical Draft, published by B. F. Sturtevant Co.*

VALVE OPERATING MECHANISM FOR STEAM ENGINES.

Mechanical Engineer, May 20, 1905.

The valve gear described below is the invention of Fried Krupp, Essen, Germany. Upon the driving shaft A of the engine is keyed a cam disk B, a portion of the periphery of the latter being concentric with the shaft A, while the remaining portion forms a cam projection b_1. Bearing upon the periphery of the cam disk B is a bowl C carried and revoluble upon a spindle c_1. This bowl lies on the side of the cam disk B opposite the length of the valve rod D, and the axes of the bowl C, the valve rod D and the main driving shaft A, are in one and the same plane with each other both when the valve is closed and when the latter is completely open. The yoke d_1 is of U-shape, and of such internal dimensions that the cam disk B can freely rotate in the yoke d_1, the lowermost portion of the latter being formed into a reservoir d_2 which surrounds the bowl C, leaving a space, however, which can be used to hold lubricating oil. The spindle c_1 of the bowl C projects on both sides beyond the walls of the yoke, and upon its projecting ends fit the eyes e_2 of a forked arm E_1 of a balance lever E E_1, the eyes being connected to the ends of the spindle by means of pins. The balance lever E E_1 oscillates on a spindle e_3 carried in a stationary standard F, and against the cup-formed end of the arm E bears a spring-pressed bolt G tending to rock the balance lever E E_1 in the direction of the arrow x, Fig. 1; the spring H bears at one end against



a collar g_1 on the bolt G, and at the other end against a stationary top of a casing J, which latter is mounted on the frame of the engine and acts as a guide for the bolt G.

The spring H is a comparatively weak spring and merely serves to balance or equalize the weight of the valve rod D and the bowl C, and also helps to keep the bowl C always in contact with the periphery of the cam disk.

The upper free end of the valve rod D is pivotally connected to the arm m_1 of a valve lever M which oscillates in a bracket bearing k_1 on the valve casing K and transmits the motion of the valve rod D to the spindle n_1 of the valve disk N. The valve disk N is held down on its seat by the spring P which is considerably stronger than the spring J.

Owing to the peculiar connection of the bowl C with the valve rod D effected by the yoke d_1, it will be seen that the arrangement of the valve operating mechanism is rendered very compact and at the same time the mechanism insures that the valve rod is subjected to tension only; moreover the torsional stresses on the shaft are reduced to a minimum. These are advantages which become specially prominent in the case of large engines with very wide bed-plates and long valve rods which bend easily.

OIL SEPARATOR.

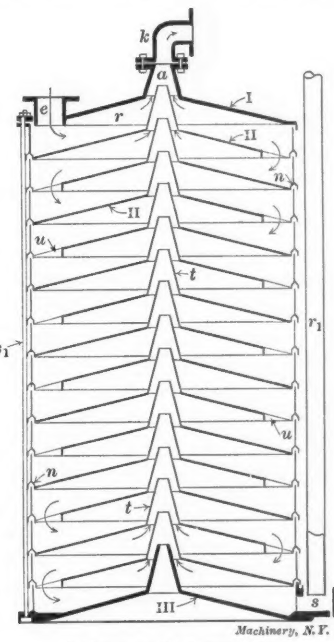
Der praktische Machinen-Konstrukteur, February 2, 1905.

The apparatus shown in section in the illustration serves the purpose of automatically removing the oil from the water of condensation in a very simple and efficient manner.

It carries a lid, I, shaped like an inverted funnel. It is fitted with an inlet e and an outlet a, and beneath there may be any desired number of plates, II having openings u in the top, and a cone rising from the center, while the bottom III is provided with a side bracket S from which the pipe r' rises.

Each plate has a groove n at the periphery which rests upon a ring on the one below, so that the whole nest can be tightly fastened together by three screws s, and leakage prevented. The apparatus is made entirely of cast iron and only three patterns are needed.

The water containing the oil flows in at the inlet e into the upper space r and thence with a diminished velocity down through the opening u to the next chamber, thence into the third, and so on. This continues until the apparatus is full. Any further influx of water is relieved by an escape through the pipe r'.



A German Oil Separator.

While the water flows slowly over the plates and from one chamber to the next, the oil, which is specifically lighter, tends to gather on the under surfaces and flow towards the center, and finally rises up through the cones t, in which there is no upward circulation of water, toward the outlet k. As the water flows down toward the bottom of the apparatus, the tendency of the oils to separate from it increases. G. L. F.

ADVANCE IN THE MECHANISM OF STEEL WORKS.

Iron and Machinery World, June 3, 1905.

One of the latest ideas, which is about to be carried out on a very large scale with regard to steel rail mills, is that the rolls shall be driven by motors, whose powers will be developed by gas engines driven by the gas from the blast furnaces, says a foreign exchange. The power thus obtained will be delivered as current to motors at the rolls, to which they will be connected by gear, and will supplant the present steam engines now in use for driving these rail mills. The improvement in plate mills for rolling steel plates is as great as that which has taken place in the steel rail mill. Thirty-five years ago a plate mill making 100 tons of plates per week was considered to be doing fair work. To-day a mill making a similar class of steel plates, but of much larger area, is turning out easily about eighteen times that quantity, and in America the enormous make of 450 tons has been rolled in twelve hours.

These large quantities are again due to improvements brought about by mechanical appliances, for handling large ingots or blooms weighing many tons with greater ease than was formerly the case when the weight of the ingots was only hundredweights handled by manual labor. Krupp was considered to have done marvelous work in showing an

ingot weighing about a couple of tons to the Exhibition in 1851, though it must be remembered that this was made from crucible steel. To-day ingots can be made of almost any weight, and their size is practically governed by the power of appliances used for moving them. At the St. Louis Exhibition a model was shown of a cylinder weighing 150 tons which had been cast in nickel steel for a 10,000-ton forging press. Ingots of 60 tons weight for armor plates are not infrequent.

In plate mills the improvements in rolling engines, the adoption of universal rolling trains, enormous hot slab shears, cranes of all descriptions for handling, charging, and drawing material from heating furnaces, cooling and straightening roller tables, cold shears capable of cutting plates up to 2½ inches thick, cooling-floors fitted with caster rollers by which these heavy plates are easily moved, have all contributed to the great outputs of steel rolling mills, and have enabled steel plates to be produced at prices not dreamed of in former years. While referring to the improvements in making steel plates and rails, one must not omit to mention the great strides made of late years by hydraulic forging. The forging press has been much improved upon. Hydraulic presses of 5,000 and even 10,000 tons are not uncommon, and for working large masses the hydraulic forging press seems to have almost replaced the steam hammer.

LARGE STEAM TURBINE INSTALLATIONS.

Electrical Review, July 22, 1905.

With the successful closing of recent negotiations for two 7,500-kilowatt Westinghouse turbine type generating units, the New York Edison Company has inaugurated an important epoch in the history of metropolitan electric lighting in this country by adopting generating units of such unprecedented size.

The importance of this step is enhanced by the fact that these turbine units will be installed in the finest and largest of American central stations, Waterside station No. 2, that ultimately will contain ten units of the same size. Waterside station No. 1 is equipped with Westinghouse vertical three-cylinder compound superheated reciprocating engines which, although installed only a few years ago as then representing the highest type of large engine construction, have so soon been outclassed through the rapid advance of the steam turbine system. No less than eleven of these large engine type units are now in service in this station, each rated at about 6,500-horse-power capacity and direct-connected to a 3,500-kilowatt generator. The next step in the acquisition of larger units resulted in the installation of 5,000-kilowatt turbine units of the Curtis type.

In the equipment of the new Waterside station with Westinghouse turbine units of still greater capacity, over twice that of the original engine-type units, there will here exist a striking example of the extremely rapid development in power-station construction that has taken place since 1900.

The compactness of the new generating unit is evidenced by the small space it requires in the new power-station arrangement. Its overall dimensions are approximately: length, fifty feet; width, seventeen feet; height, fifteen feet; floor space, 850 square feet per unit net, or 0.113 per square foot per kilowatt capacity. A condenser of the surface type will be located beneath the turbine in the foundations proper.

The new turbines will operate under 175 pounds steam pressure, approximately twenty-eight inches vacuum and 100 degrees superheat, the normal speed of the unit being 750 revolutions per minute. Under these conditions the economy of the complete unit will be in the neighborhood of sixteen pounds per kilowatt-hour at full-rated load. Each unit will have an overload capacity of at least fifty per cent or will be capable of developing full-rated load without the use of a condenser. A distinctive feature of this design is that the turbine gives its best economy around full-rated load, although a large overload capacity is at all times instantly available when required without material sacrifice of efficiency. At this maximum load each turbine will be developing over 15,000 horse-power at the shaft, which is by far the greatest amount of power ever developed in a single prime-mover in stationary service.

The direct-connected turbo-generators will be of standard Westinghouse construction, delivering 6,600-volt, three-phase current to the high-tension network at a frequency of twenty-five cycles per second. The generators will embody the new enclosed construction which constitutes an important advantage in the entire elimination of the hum peculiar to high-speed turbine generators. They will have an efficiency approximating 97.5 per cent at full-rated load. Each generator will be able to sustain for several hours an overload of fifty per cent within reasonable temperature rise.

It is of interest in connection with this important installation that almost simultaneously three Westinghouse turbine units of the same size have been adopted by two large Brooklyn power stations, one for railway and the other for lighting service, making a total of over 50,000 horse-power in turbine machinery of this size. Two units will go to the Brooklyn Heights Railway Company and the third to the Brooklyn Edison Company.

THE HATCHET PLANIMETER.

Arthur B. Allen, in the Engineer, July 15, 1905, p. 481.

It is a singular thing that the hatchet planimeter has not come into general use instead of the more elaborate and costly instruments commonly employed, for it is capable of a very high degree of accuracy, cannot get out of order, and is most simple to make. The present writer has, for example, made a first-rate instrument out of an old steel spindle, with the aid of such tools as are to be found in the abode of any engineer, bending the steel, as seen in Fig. 1, in a gas flame. There is no reason, therefore, why everyone should not be equipped with a planimeter of this type.

To make it, all that is required is a steel rod about 15 or 16 inches long, and perfectly tapered toward both ends—the steel spindles used in cotton mills are just right for the purpose, being 16 inches long, 5/16 inch diameter at the thickest part, and nicely tapered both ways to about ⅛ inch. Usually the planimeter is made with two short legs, of equal length, but the writer finds it a very great improvement to make the pointed end about 4 inches long, to facilitate manipulation in tracing round the diagram. Of course, tapered spindles are not essential; a plain steel rod will do quite well.

First roughly file up the thinner end to a long point, and then finish the latter to a fairly sharp, but not too sharp, point to serve as the stylus, taking care to keep the shape true and symmetrical. A hone is the best tool for nicely finishing the stylus. Next bend the pointed end through rather more than a right angle, allowing such a length that the height over all is 4½ inches when the point is upright. Then bend the other end somewhat less than a right angle, exactly parallel with and on the same side as the former, allowing a length of about 1½ inch. This end must now be filed and finished to a sharp hatchet edge, slightly curved, with the line of the edge passing through the point first made. True alignment is important, and can be fairly well accomplished by guiding the point in the same plane as that of the surface of the hone when applying the finishing touches. The last operation consists in accurately adjusting the distance from the point or stylus to the center of the hatchet edge to 10 inches, by slightly bending the steel more or less at the angles. The length of 10 inches is preferable for general work, not only because it is a handy length, but also because it reduces the arithmetic. Five inches, or any other convenient length may be taken if preferred.

Having completed the instrument, the method of using it is shown in Fig. 2. Fix the diagram on a flat board, such as a drawing board or table, and pin down also a sheet of smooth paper (preferably on the further side of the diagram) at such a distance that the hatchet edge will not run off the paper when tracing around the diagram with the stylus. Guess the position of the center of gravity of the diagram, and draw a line from it to the boundary of the latter. Then place the stylus on the assumed center of gravity, and gently press the hatchet so as to make a slight indentation in the paper. Now, without lifting the planimeter, trace round the diagram with the stylus, finally returning to the starting point; when this is reached, again press the hatchet so as to mark the paper. Without lifting the planimeter, and keeping the point pressed down on the diagram, rotate the diagram through about two

right angles, fix it, and again trace around its boundary, but this time in the opposite direction. Finally, having returned to the center of gravity, press the hatchet into the paper for the third time.

There will now be three marks, as shown in Fig. 2, at 1 and 3 and 2, the first and last close together, and the intermediate one at a distance from them. Measure the distance between the distant mark and the mean of the other two as accurately as possible with a pair of dividers, and multiply this distance by the length of the planimeter; the result is the area of the diagram. From this the mean height can be found, by dividing the area by the length of the diagram.

It is to be noted here that starting from the center of gravity of the figure or diagram is essential to success; if this is not done, serious errors will be incurred, rendering the meas-

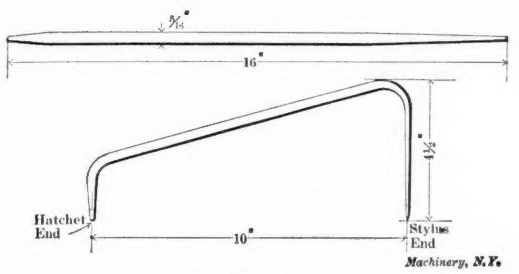


Fig. 1. The Hatchet Planimeter.

urement quite useless. Rotating the diagram through two right angles and going round it in the opposite direction, is done in order to correct for the inaccuracy of the original guess at the position of the center of gravity. But it is not always sufficient to make this correction. It is not easy to make the hatchet edge exactly in line with the stylus; this error can be detected by placing the hatchet and stylus on a penciled straight line, and drawing the stylus along the line, when the hatchet will be found to gradually run off the line unless the alignment is perfect. On account of this the writer finds it preferable to trace around the diagram in each direction before turning it round, and again after doing so. This gives four values for the displacement of the hatchet, the mean of which is taken with the dividers.

The latter measurement is important, as any error in its determination reappears in the result; it is best made therefore with a pair of fine dividers, and read off on a diagonal scale in, say, 0.04 of an inch. When a 10-inch planimeter is used, and the area of the diagram is small, the displacement of the hatchet is also small, and in this case a great increase in accuracy can be obtained by going round the diagram sev-

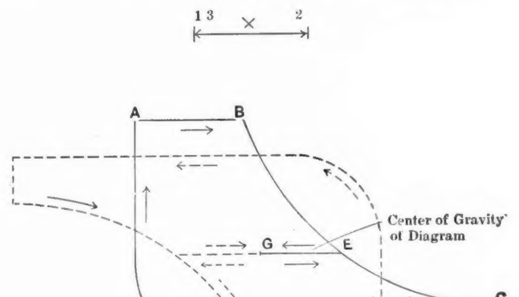


Fig. 1. Method of using Hatchet Planimeter.

eral times in one direction, then the same number in the other, and dividing the result by the number of times. By using a shorter planimeter, the displacement of the hatchet is proportionately increased; and if the length of the planimeter is the same as that of the diagram, the mean height of the latter is given at once by the displacement of the hatchet; the writer, however, prefers to use the 10-inch instrument for all purposes, and thinks that a shorter length than 5 inches should not be used.

By adopting the precautions described above, with a carefully made planimeter, an accuracy of 0.5 per cent is easily obtained, and this is usually a higher degree than necessary, for few diagrams are reliable to 1 per cent. The process appears far more complicated than it is in reality; in fact it is extremely easy and simple.

In conclusion it is important to observe that the paper on which the hatchet works is hard and smooth; that the planimeter is held upright while tracing, and that the point accurately follows the boundary of the diagram. This, of course, applies equally to all planimeters. If at the first attempt a high degree of accuracy is not attained, do not be in a hurry to blame the instrument; a planimeter needs practice, like any other measurement, before accuracy can be assured. It is a good plan to draw a right-angled triangle or a rectangle of dimensions similar to those of the diagrams to be measured, ruling in the lines with a hard pencil until there is quite a distinct groove, in which the point of the planimeter will run without deviation; then trace this repeatedly, first in one direction and then in the other, and measure accurately the displacement of the planimeter hatchet each time. If the hatchet and point are in correct alignment, and the lines are closely followed, the displacement will be exactly the same, no matter which way the point goes round the diagram; and if the start is always made from the center of gravity, the result will be independent of the position of the diagram. The hatchet should be fairly sharp, and curved to a radius of about 1/8 inch.

ON THE STRESSES THROWN UPON BOLTS BY THE WRENCH.

The Locomotive, July, 1905.

It is impossible to make any accurate computation of the tensile stress that is thrown upon a bolt, by screwing up a nut upon the end of it; but it is possible to obtain a roughly approximate estimate of that stress, when the nut is set up under given conditions.

Let us suppose that a given screw is provided with a nut, which is to be turned up solidly against some resisting structure, so as to throw a tensile stress on the screw. Let the nut be turned by means of a wrench whose effective length is L inches. When the nut has been brought up pretty well into place, let us suppose that a force of P pounds, when applied to the end of the wrench in the most effective manner, will just move it. The work done by the man at the wrench, per revolution of the nut under these circumstances, is found by multiplying the force P, by the circumference of the circle described by the end of the wrench. The wrench being L inches long, the circumference of this circle is $2\pi L$ inches, where π stands for the decimal number 3.1416. Hence the work performed by the workman, per revolution, is $2\pi LP$ inch-pounds. Let us assume, for the moment, that the screw runs absolutely without friction, either in the nut, or against the surface where the nut bears against its seat. Then the work performed by the workman is all expended in stretching the screw, or deforming the structure to which it is attached. Hence if the screw has n threads per inch of its length, and T is the total tension upon it in pounds, the work performed may also be expressed in the form $T \div n$; for in one turn the screw should be drawn forward by $1 \div n$ inch, against the resistance T. Under the assumed conditions of perfection, the two foregoing expressions for the work done must be equal to each other. That is, we should have $2\pi LP = T \div n$, or

$$T = 2\pi nLP.$$

from which we could calculate the tension, T, on the bolt, if the screw were absolutely frictionless in all respects.

We come, now, to the matter of making allowances for the fact that in the real screw the friction is very far from being negligible. The actual tension that the given screw would produce in the belt will be smaller than the value here calculated, and the fraction (which we will denote by the letter E) by which the foregoing result must be multiplied in order to get the true result is called the *efficiency* of the screw. The efficiency of screws has been studied both experimentally and theoretically; but the experimental data that are at present available are far less numerous than might be supposed, considering the elementary character and the fundamental importance of the screw, in nearly every branch of applied mechanics. In the *Transactions* of the American Society of Mechanical Engineers, Volume 12, 1891, pages 781

to 789, there is a paper on screws by Mr. James McBride, followed by a discussion by Messrs. Wilfred Lewis and Arthur A. Falkenau, to which we desire to direct the reader's attention. In this place Mr. Lewis gives a formula for the efficiency of a screw of the ordinary kind, which appears to be quite good enough for all ordinary purposes, and which may be written in form

$$E = 1 \div (1 + nd),$$

where d is the external diameter of the screw. If we multiply the value T, as found above, by this "factor of efficiency," the value of T, as corrected for friction, becomes

$$T = \frac{2\pi\, nLP}{(1 + nd)}$$

As an example of the application of this formula, let us consider the case in which a workman turns up a nut on a two-inch bolt, by means of a wrench whose effective length is 50 inches; the maximum effort exerted at the end of the wrench being (say) 100 pounds. A standard two-inch bolt has 4.5 threads per inch; so that in this example the letters in the foregoing formula have the following values: $n = 4.5$; $L = 50$ inches; $P = 100$ pounds; $d = 2$ inches; and π (as usual) stands for 3.1416. Making these substitutions, the formula gives

$$T = \frac{2 \times 3.1416 \times 4.5 \times 50 \times 100}{(1 + 4.5 \times 2)} = \frac{141.372}{10} = 14{,}137 \text{ pounds.}$$

That is, the actual total tension on the bolt, under these conditions, is somewhat over 14,000 pounds, according to the formula. As another example, let us consider a screw 1.5 inch in external diameter, with the nut set up with the same force and the same wrench as before. A standard screw of this size has six threads to the inch, so that the formula gives in this case,

$$T = \frac{2 \times 3.1416 \times 6 \times 50 \times 100}{(1 + 6 \times 2)} = \frac{188{,}496}{13} = 14{,}500 \text{ pounds.}$$

or a total tension on the bolt of 14,500 pounds.

CASTING IN METAL MOULDS.

Walter J. May, in the Mechanical World. June 3, 1905, p. 203.

There is nothing very new or striking in the use of metal moulds in foundry work, yet there are openings for fresh uses for metal moulds in some directions, particularly with some of the softer and more-easily melted alloys. Where iron is concerned, metal moulds or parts are used as "chills" for various purposes, the castings being made of metal which possesses the property of chilling to a more or less great depth. The whole surface, or parts of the surface only, may be chilled and hardened, and the treads and flanges of car-wheels and the like may be chilled, while the other parts are left as soft as the character of the iron used will permit. Larger use could be made of chills in the production of hardened work than is at present the case, especially where friction has to be provided against; but very probably the hardness of chilled metal and the trouble in tooling it prevent its more extended use. At the same time there is no reason why chilled iron should not be ground to shape, while for many purposes grinding is far cheaper than other methods of machining metals. In all cases the metal moulds, or "chills," should be faced up properly, and when used for casting, a coat of plumbago, charcoal, or other protective material should be put on the surfaces which come in contact with the molten metal.

In rolling and tube-drawing mills making their own strip and tube ingots, metal moulds are used, and under the ordinary conditions of the casting shop give good results. The moulds are coated with chalk, plumbago, steatite, or other material, and when dry are poured on end; and while occasionally spilly metal occurs, yet generally sound castings, well fitted for the purposes to which they are put, are produced. The moulds should be of good iron, and should be very smoothly cast, or machined smooth, while the coating of carbon or other matter should be applied evenly, otherwise the metal ingot produced will not be smooth on the surface.

With lead and soft metals of this class, bronze, brass, and iron moulds are generally used where large numbers of the same article are needed; and provided the moulds are kept brushed out with plumbago or steatite, the castings come out with a smooth and finished surface. Bullets, toy soldiers, and such like things are turned out by the thousand from metal moulds; and where the metal is hardened, as in the case of type metal, very strong toys are produced. Type is cast in metal moulds, whether it be made by hand in the old-fashioned way or in machines, as in the Wicks rotary type caster, and others; and, of course, the linotype machines use metal moulds—matrices—of a movable character for forming the lines of type, or "slugs," as they are termed in printers' parlance. The moulds have to be very carefully made for fine and precise work, but metal moulds give finished results in these cases, and results such as could only be obtained with much labor if the moulds were roughly made. There is, however, no reason why metal moulds should not be more largely used for repetition work in soft metals, even aluminium casting very well for many patterns; but the greater the amount of contraction in any metal, the less suitable is it for use with metallic moulds, except they be of the simplest form, as in the case of ingot moulds.

Perhaps for certain classes of work in brass, well-finished metal—iron—moulds would give financial results superior to sand moulds. For instance, in some forms of gas-fitting ornaments and the like; as, properly done, only the minimum amount of finishing would be necessary. With articles of such a form as could be readily dealt with in the lathe, ordinary moulding would be cheaper and probably better, the cost of finishing such work being small; but where work difficult to finish is dealt with, the matter would be different, as with good moulds only the smallest amount of filing would be necessary. Given smooth, well-finished moulds, coated with steatite or plumbago and poured with clean brass at a fairly low temperature, castings quite smooth enough for dipping should be produced, and hundreds of castings could be obtained from a cast-iron mould, or with a forged wrought-iron mould thousands of castings could be made, there being no danger in cooling the moulds. Some difference in practice has to be overcome in dealing with metal moulds, but this presents no serious difficulty if one means to succeed.

The advantage of using metal moulds for large lots of small and medium-sized castings is in the saving in skilled labor in moulding in sand, as with a sufficiency of moulds two men and one or two boys will cast more metal in a week than a dozen moulders can turn out, and this with very little teaching. Of course, the proper melting of the metal must be known. but this is not difficult for an intelligent man to get a hold on, although alloying is more difficult; but even this is easily learned when the proportions of the different components of an alloy are given. For large numbers of castings the advantage of permanent moulds in maintaining uniformity in the castings is also a matter of moment, and particularly as with carefully made and prepared moulds many classes of work would require practically no finishing before being ready for paint or other decorative application to be put on. In fact, from many points of view the reductions in cost would be such that it would pay for the comparatively heavy costs of the moulds, as only one expense would be made against the many expenses in moulding in sand.

The disadvantages would consist in the inapplicability of the use of metal moulds for small numbers of castings, and to the limits of size which would of necessity take place. The form of the castings would have to be fairly simple so that they would shrink away from the mould, and not on to parts of it, and this to some extent limits the application of permanent moulds. Cores could be readily used in the majority of cases, provided they were well made, and the moulds could be in more than two parts if well fitted.

There is a wide field still open for the use of metal moulds in casting a wide range of metals and alloys, and the subject is well worth the attention of makers of large numbers of cheap castings of similar form, the cost of cast-iron moulds not being prohibitive. Some moulds could be made with fine skins on the shaped portions, so that machining or other

tooling would be unnecessary except at the joints, the iron being cast with either a smooth or grained surface, as needed; but of course the cost of fine castings is higher than that of the ordinary work which has to be machined. The writer has cast iron moulds for various alloys which have not needed any machining, and the castings from such moulds have come out quite smooth on the face and sharp in detail; but all cast-iron moulds could not be so well done.

WATER GAGES FOR STEAM BOILERS.

Portefeuille Economique des Machines, November, 1904, p. 161.

The principal qualities that a water glass must possess are visibility, ease of cleaning, and ease of replacement. Visibility depends to a great extent on the location of the apparatus. But in spite of the fact that it is seldom far removed from the fireman, various devices have been resorted to to increase the distinctness of the water line. The one most frequently

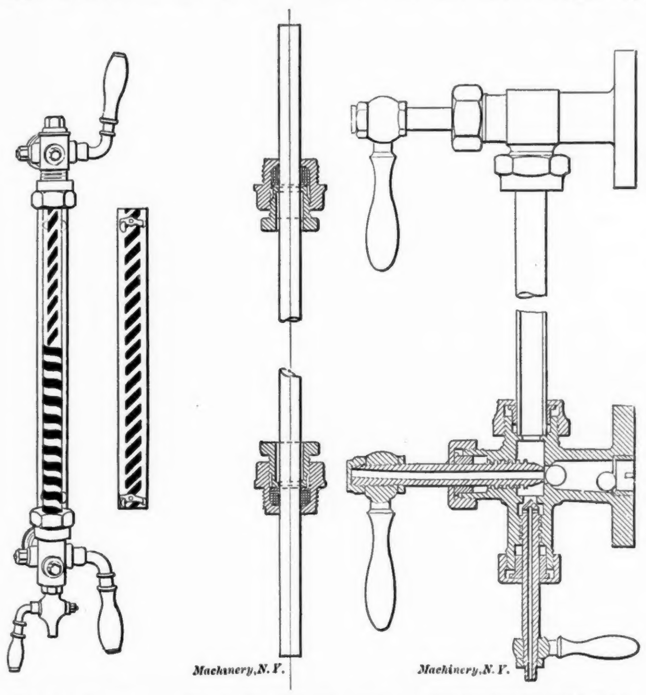


Fig. 1. Cooper Banded Water Glass. Fig. 2. Berthelot's Removable Packing Boxes. Fig. 4. Dumay Gage Cock with Hollow Handle for Cleaning.

used is that of a red longitudinal band, which appears narrow above the water line and broad below it. There is danger, however, that the incorporation of a red band into the body of the glass will destroy its homogeneity, injure the uniformity of its expansion and render it liable to crack. The red band has also been applied to the outside of the glass, either in contact with it or with a space between.

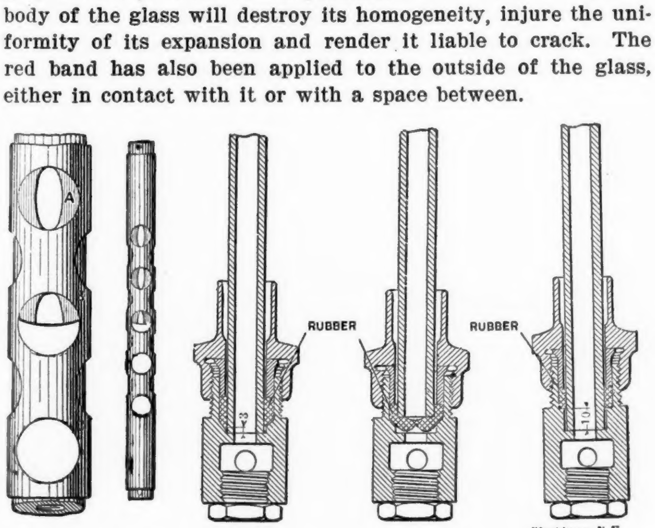


Fig. 3. Carre's protected Water Glass. Fig. 5. Glass Mounting with Packing too low. Fig. 6. Effect of low Packing. Fig. 7. Preferred Arrangement for Figs. 5 and 6.

Instead of the continuous band, one broken by non-colored intervals has been used, the effect of which is shown in Fig. 1; an effect that is due to the combination of the optical properties of the glass and the water.

Carré's water glass is covered with a metallic shield in which there are three circular openings, the effect of which is that where the water is below the hole the latter appears as an ellipse with the major axis vertical. Where the water level is above the top of the hole, the latter shows a full circle and where it cuts through the hole the latter shows a full circle at the lower part and an eclipse with the major axis vertical at the upper, as shown in Fig. 3.

The passages of the tube and cocks gradually become coated with scale and they would soon be sealed were they not cleaned from time to time. That this may be done with ease the Dumay gage cock has a hollow handle with a cap over the outer end, as shown in Fig. 4.

Water glasses should be arranged so as to be quickly renewed whenever the inner surface roughened by the steam has lost any of its transparency, when the surface has become corroded, or the tube has been broken.

It is essential that the effects of broken tubes should be minimized and one of the most efficient means to this end is the use of a high grade of glass. There are some qualities of glass tubes that are quickly attacked by steam, the small drops of water that are condensed in the upper portion run down the inside and cut grooves in the glass so that the latter is gradually weakened, until the tube, no longer able to withstand the pressure, bursts. This can best be avoided by replacing the tube after a certain period of service.

Attention is also called to the fact that water glasses exposed to currents of air, as in the case of locomotives running backward, break more frequently than those that are always sheltered.

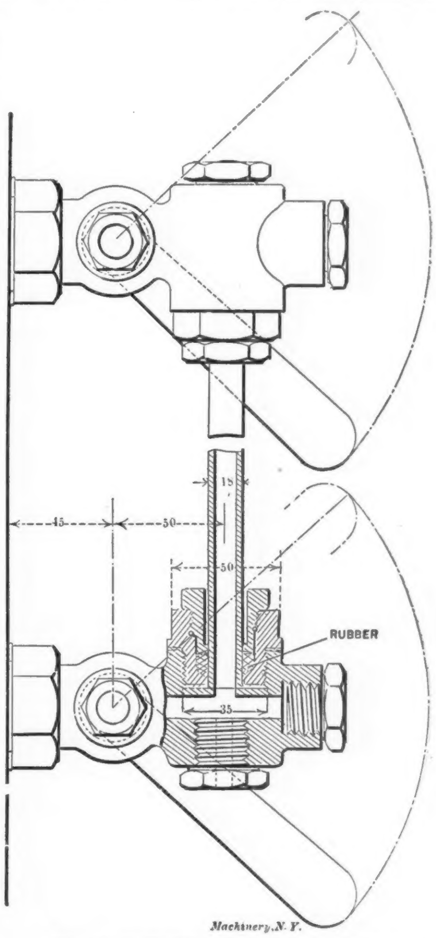


Fig. 8. Berthelot Removable Mounting.

Manufacturers of glass tubes have, therefore, attempted, by the use of special materials and carefully worked-out methods of manufacture which include the tempering and annealing at well-regulated temperatures, to produce a glass that will resist sudden variations of temperature, the attacks of steam and the effects of pressure. In this they have succeeded so well that tubes are on the market to-day that have a tensile strength of 5,000 pounds per square inch of section and which will carry with safety an internal hydraulic pressure of 5,700 pounds, or a steam pressure of 450 pounds. Such tubes have a durability that fully makes up for the high price charged for them.

Defective mounting is one of the most prolific causes of broken water glasses. When a new tube is put in place the packing is sometimes badly centered or carelessly adjusted, so that the glass comes in contact with some of the metallic parts. The result is that an attempt to stop a slight leak by screwing down the gland, but which the slant of the glass increases, ends in a fracture. Sometimes the packing slips beneath the tube, thus checking all possibility of expansion and is a sure precursor of breaking. This often occurs also when the stuffing box comes down too low, as in Fig. 5. The

packing is then likely to get into the position shown in Fig. 6. In order to avoid this inconvenience it is well to make the stuffing box of the shape shown in Fig. 7. If necessary, the depth of this chamber can be decreased by putting a brass ring in the bottom.

The replacement of water glasses can be very quickly effected by the use of the design shown in Fig. 8, with which the stuffing boxes can be put in place while the glass is held in the hand and the boxes afterward screwed into place.

The use of a connecting pipe or water column between the two points where steam and water respectively are taken from the boiler diminishes the amount of condensation in the latter and with it the wear, while the amount of scale deposited in or near the tube is also lessened.

There is a difference of opinion as to the use of a cock or a valve worked with a screw, for cutting off the connection between the boiler and the glass.

The latter is preferred on account of the ease of manipulation, while the former sometimes sticks. On the other hand, the cock is much more rapidly closed. G. L. F.

* * *

BEAM FORMULAS.

SANFORD A. MOSS.

In the data sheet accompanying this number is an extensive table of formulas for the stresses and deflections in beams, shafts, etc. Below are partial tables of the properties of materials, and of cross-sections. These latter tables are readily accessible in the various mechanical handbooks, etc., so that completeness is not here aimed at. No table of formulas for stresses and deflections has ever been given, however, which completely covers usual cases, and the present data sheet table is an attempt to supply the deficiency. It is probably the most complete one ever published.

The explanations accompanying the tables are such that any one may use them, without previous knowledge of the subject. All details are covered by the three tables, in a form convenient for quick and ready reference. It is not requisite that one have the details of procedure at one's finger-ends in order to quickly solve a problem, as is the case with most tables on this subject. Especial pains have been taken to reduce the formulas to that form most convenient for use in computations.

The formulas have all been worked out from first principles especially for this publication, and carefully checked so as to eliminate errors. Care has also been taken to avoid typographical errors, which make many simliar tables unreliable.

Table I. Properties of Materials used for Beams.

This table gives a partial list of *average* values. Authorities differ very widely as to the proper values, and it may be often desirable to use other values than those here given.

MATERIAL.	E, Modulus of Elasticity, lbs. per sq. inch.	s, Maximum Safe Stress, lbs. per square inch. For Dead Load, *i. e.*, one which never varies.	For Live Load, *i. e.*, one frequently varying from Zero to Maximum.	For Reversing Load, *i. e.*, one Alternately in Opposite Directions.
Cast iron, tension	17,000,000	3,000	2,000	1,000
Cast iron, compression	17,000,000	12,000	8,000	1,000
Wrought iron	27,000,000	15,000	10,000	5,000
Mild steel	29,000,000	16,500	11,000	5,500
High carbon steel (oil tempered)	29,000,000	21,000	14,000	7,000
Nickel steel (oil tempered)	29,000,000	45,000	30,000	15,000
Steel castings (annealed)	29,000,000	12,000	8,000	4,000
Manganese bronze	14,000,000	15,000	10,000	5,000
Phosphor bronze, aluminum bronze, etc.	14,000,000	10,000	6,600	3,300
Bronzes or gun metal (copper-tin alloys)	12,000,000	4,200	2,800	1,400
Brasses (copper-zinc alloys)	12,000,000	3,000	2,000	1,000
Copper (rolled or drawn)	16,000,000	3,000	2,000	1,000
Wood (average)	1,500,000	1,500	1,000	500

Table II. Properties of Cross-sections of Beams.

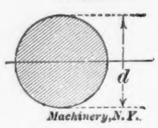
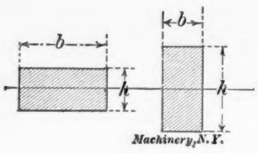
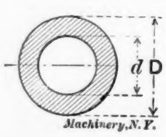
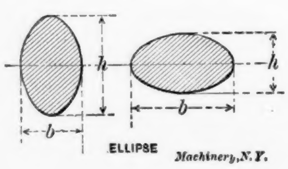
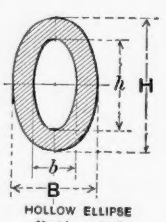
All Dimensions in Inches.

The following is a partial table, containing usual cases. More complete tables will be found in various engineering reference books. The quantity Z, here called the "Section Modulus," is often called "Moment of Resistance," or sometimes simply "Resistance." Values of the Moment of Inertia and Section Modulus for I-beams and other rolled shapes are given in the handbooks issued by the various steel companies.

The *Axis* of the cross-section is that line through its center of gravity perpendicular to the plane in which the beam is bent. It is indicated by a broken line in the figures below. The Moment of Inertia and Section Modulus for a given section vary according to the axis, and care must be taken that the proper value is used.

The *Moment of Inertia I* of a cross-section, with respect to a given axis, is the sum of the products found by multiplying the area of each element by the square of its perpendicular distance from the axis.

The *Section Modulus Z*, of a cross-section with respect to a given axis, is the quotient I/c, where c is the perpendicular distance of the outermost fiber from the axis, and I is the moment of inertia with respect to the same axis.

Section. All dimensions in inches.	I. Moment of Inertia. (inches)^4	Z. Section Modulus. (inches)^3
	$\frac{\pi d^4}{64}$ or $.04909\, d^4$	$\frac{\pi d^3}{32}$ or $.09817\, d^3$
	$\frac{b h^3}{12}$	$\frac{b h^2}{6}$
	$.04909\,(D^4-d^4)$	$.09817\,\frac{D^4-d^4}{D}$
 ELLIPSE	$.04909\, b h^3$	$.09817\, b h^2$
 HOLLOW ELLIPSE	$.04909\,(B H^3-b h^3)$	$.09817\,\frac{(B H^3-b h^3)}{H}$

* * *

HIGH PRICES NINETY YEARS AGO.

At this time, while every one is complaining of high prices and almost all trades are endeavoring to get wages raised, it is interesting to note what the price of groceries were ninety years ago. In a recent consular report Marshal Halstead, U. S. Consul at Birmingham, England, quoted from an old price list of 1814 which shows that the price of tea, coffee, sugar, figs, raisins, rice, were from 50 to 600 per cent. higher than now. For example, tea was quoted at \$1.74 to \$2.68 for the same quality which can now be purchased for 40 cents per pound; coffee, 49 to 67 cents for which 40 cents is now paid; sugar was 36 cents, present price 6 cents; figs, 23 cents, present price 8 cents. These prices are for English markets. It is pointed out that one reason for the very high prices on some commodities in 1814 was the risks attendant to ocean transportation before the days of steamships..

IMPORTANCE OF GOOD CLAMPING FACILITIES IN MACHINING LARGE WORK.

G. Q. ROSS.

I enclose some cuts of machine tools which illustrate clearly the methods used at the works of the Bullock Electric Mfg. Co. for rapidly and rigidly chucking their large work. About one year ago this company started the introduction of the bonus system throughout their plant with the intention of gradually doing away with the premium system which had been for a number of years, and in fact is at the present time, in successful operation, the claim made for the bonus system being that it would enable the foremen to know where the weak points in their methods were, and consequently where the time was being lost. So far as determining this information was concerned the system was a decided success, and had it not been for the immense amount of clerical work required to make out the "operation" cards, would have been adopted in place of the premium. It was an easy matter to figure the speeds, feeds, number of cuts, etc., on a given piece and comparatively easy to see that the workman kept up to the mark, but the total time consumed on a job of any size was always about double what was "figured" out.

Upon investigation it was found that the entire time was consumed mostly on account of a poor supply of the most common accessories of a machine shop, such as clamps, dogs, drivers, chucks, wrenches, cutting tools and bolts, nuts, washers, heel blocking, etc. Although bolts with forged T-heads had been bought by the hundred, it was almost impossible to find one, when needed, with a good head, good thread, and of the proper length.

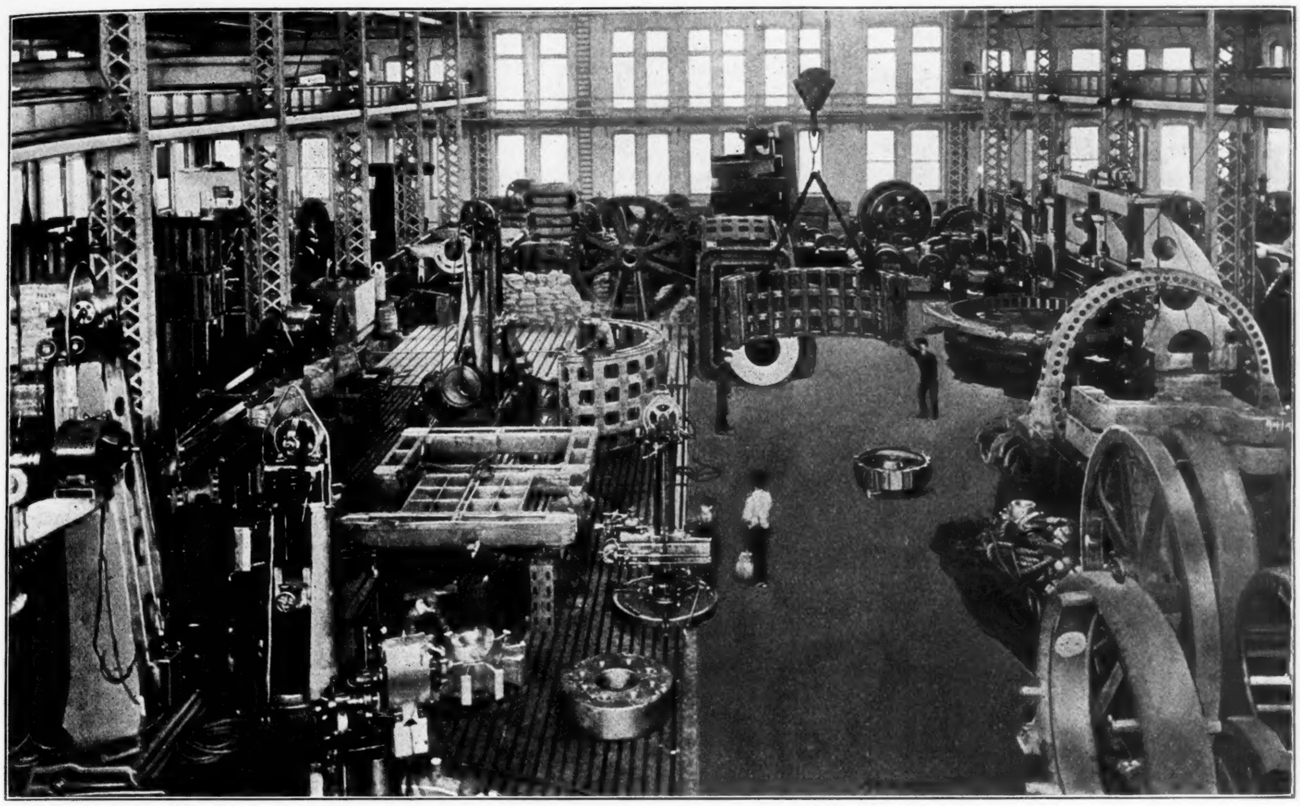


Fig. 1. General View of a Bay in one of the Bullock Electric Mfg. Co.'s Shops, showing Floor Plates and Portable Tools. The Work is such that the Time Spent in Setting up is an Important Consideration.

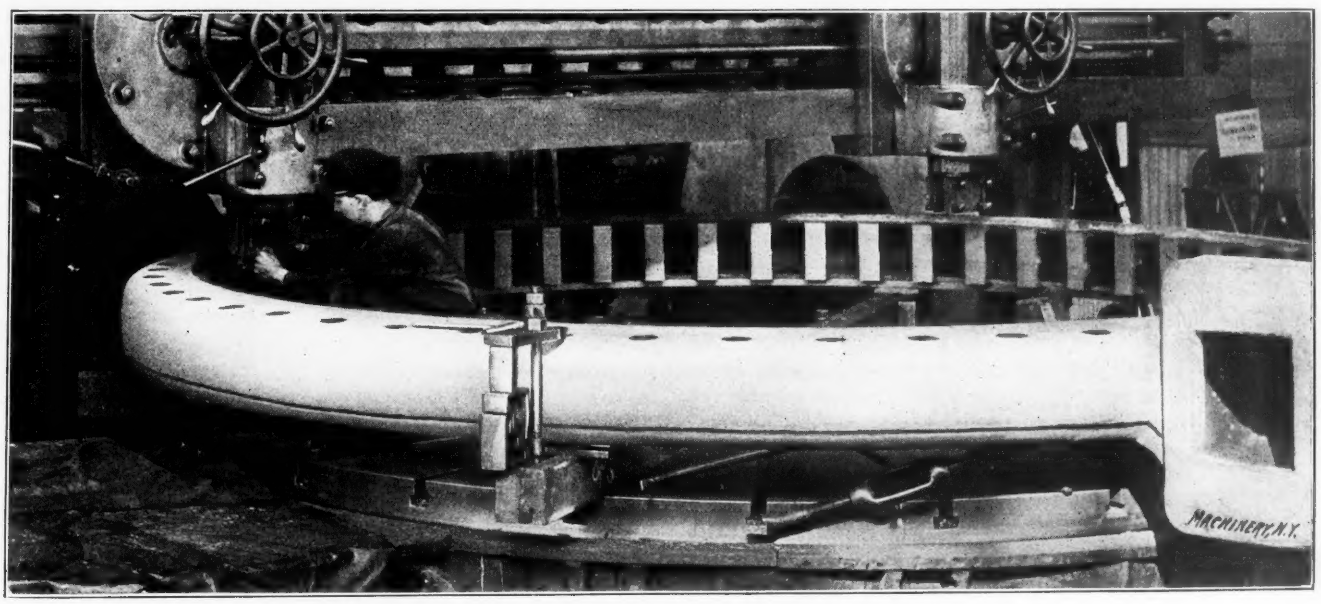


Fig. 2. Generator Frame on Boring Mill Table, showing Method of Holding Work.

Having found out where the greatest leakage was, it did not take long to decide that the junk heap around the machines must go. In its place each machine was equipped with a bolt and clamp box, supplied with from 1 dozen to 2 dozen steel T-heads,* and from 3 to 12 dozen studs ranging from

* These T-heads are made by G. R Lang Co., Cincinnati, Ohio.

3 inches to 36 inches in length, and these, supplied with nuts and washers, settled the bolt question for good. This being settled, the next move was to rid the machines of all the wooden blocking used around the shop. In their places were made turnbuckles with forked stub ends (to be used as drivers and braces) and cast iron heel blocks made in the form of a step. These were not only quicker to set up than the wooden ones but enabled the work to be held more rigidly and to stand stiffer cuts and feeds. Each machine was supplied with its own equipment throughout and nothing was allowed to be taken from one machine to another without the consent of the foreman.

The results were simply astonishing. The men took more interest in their work and showed it by the way they turned it out. The strange part of this is that it is nothing new; the men had been kicking for something to work with and instead of giving them what they needed we went hunting after "systems." After some years experience with handling men I find that the only successful system is the one which gives the man a square deal and doesn't expect him to say "peace" when there is no peace, nor find bolts when there are none to be had. I trust this will be of interest to your readers and bring out other points along the same line.

* * *

HIGH-SPEED PLANERS.

Editor MACHINERY:

We regret that Mr. A. L. DeLeeuw did not extend his investigation of the high-speed planer problem to an examination of the Chandler Planer before committing himself to the opinion and predictions made in the article that appeared over his name in the June number of MACHINERY.

We further regret that he has been unable to accept our invitation to visit our shop and subject the Chandler Planer to as many and as protracted tests as he shall deem necessary to satisfy himself that our claims are justified.

The subject of high-speed planers, as treated by Mr. DeLeeuw, divides itself, so far as belt-driven planers are concerned, into four headings:

I. Has a practical high-speed belt-driven planer been built?

II. Is the result sought by such a planer worth the effort?

III. What are the obstacles in the way of the solution?

IV. What other features besides high speed must a planer possess to be a commercial and mechanical success?

I. Has a practical high-speed belt-driven planer been built?

Mr. DeLeeuw says "The planer problem [high speed] has been attacked a number of times, by a number of persons, but with indifferent success." The Chandler planer is running, and is guaranteed to run, without sacrificing any feature of efficiency that Mr. DeLeeuw will name, at any cutting speed from 25 feet per minute to 60 feet per minute, with a return speed of 200 feet per minute. At the Fore River Shop Building Co.'s shops, Quincy, Mass., a Chandler planer is running at a cutting speed of 90 feet per minute with a return speed of 150 feet per minute.

What the Chandler planer is doing is such a flat answer to Mr. DeLeeuw as to excuse our protracting this article further. This subject is too important to be treated dogmatically, however, and we shall therefore answer Mr. DeLeeuw's arguments specifically and in detail.

II. Is the result sought by such a planer worth the effort? or, as Mr. DeLeeuw puts it, "Is the flame worth the candle?"

He expresses the opinion that using a high-speed planer is equivalent to hunting a rabbit with a six-inch rapid-fire gun. To substantiate that conclusion he supposes a cutting speed of 20 feet per minute, with a return speed of 80 feet per minute, and computes that increasing the return speed from 80 feet to 100 feet would save four per cent. That four per cent seems to be *his* rabbit. But if the return speed should be increased, not from 80 to 100, but from 80 to 200 feet, there would then be a saving of 12 per cent. If the cutting speed is 50 feet and the return speed should be increased from 80 to 200 feet, there would then be a saving of over 23 per cent. If the cutting speed is 65 feet and the return speed should be increased from 80 to 200 feet there would be a saving of over 27 per cent. Thus, contrary to the popularly accepted idea, the value of a quick-return increases with each increase of the cutting speed.

We submit that there is meat enough in that rabbit to justify the use of a six-inch rapid-fire gun. The results that we have obtained are not those of merely exhibition tests, but are, in many cases, prescribed by our customers. Here is an instance: At the request of the superintendent of the United Shoe Machinery Co., we roughed and smooth-planed a thin cast-iron test plate 12 x 48 inches with one tool point on a 24 x 24 x 6 foot planer in 17 minutes. We suggest that Mr. DeLeeuw put this job on some planer in which he has confidence, and report the results in these columns.

III. What are the mechanical obstacles in the way of high-speed planers?

We are under obligation to Mr. DeLeeuw for emphasizing the obstacles that, in his opinion and experience, stand in the way of a successful high-speed belt-driven planer. The various problems to which he refers were appreciated by Mr. Chandler from the first, and we submit that they have been overcome in his planer.

1. Pulleys. On our large size planers the speed of the tight pulleys exceeds the safety point of cast-iron pulleys, and we are aware that no commercial steel pulley fills the bill. Our high-speed tight pulleys are steel forgings of our own invention and construction. Their great strength permits increased speed, and their lightness reduces the momentum problem on reversal.

2. Shafts. We agree with Mr. DeLeeuw that no ordinary shaft can be run at the speed, and do the work we guarantee. All shafts in the Chandler planer are casehardened and ground. So far as we know, we are the only persons who have successfully casehardened pieces as large as planer shafts. With these shafts we have less difficulty at the high speeds than the ordinary slow planer has with the ordinary shafts. For the purpose of testing the shafts, we have repeatedly permitted them to run until they have become dry and heated and finally stuck, and then cooled them off, oiled them up, and started again. In no instance have the shafts cut.

3. Lubrication. All loose pulleys on the planer are fitted with grease cups and are guaranteed to run two weeks without re-filling.

4. Overcoming the shock of reversal.

We agree with Mr. DeLeeuw that bunters, buffers and friction clutches are all failures. The momentum and inertia to be overcome are in the rapidly running pulleys and gears and not at all in the platen. Mr. DeLeeuw's analysis is scientifically correct. We, therefore, grapple the problem at the long end of the lever. We accomplish the reversal by the belts, and in no place is a belt required to do any more than has been repeatedly and successfully accomplished from time immemorial.

We take the cutting speed as a basis, and we put it anywhere that steel will cut. Suppose the cutting speed is 50 feet per minute. At the end of the cutting stroke we make the best reversal we can, say two to one, which is our usual ratio of reversal from 50 feet. The platen starts back at a speed of 100 feet per minute. As soon as it is under way the tappet encounters another step on the reversing dog, and the reversing belt is thrown off, and the high-speed belt, which accelerates the platen speed from 100 feet to 200 feet—a relatively easy matter—is thrown on. At the end of the return stroke the belts are manipulated in reverse order; that is, the high-speed return belt goes off, and the reversing belt goes on. This brings the platen speed down from 200 to 100 feet per minute, from which it is easily reversed to the cutting speed.

IV. What features besides high speed must a high-speed planer possess to have an all-round commercial and mechanical value?

We agree with Mr. DeLeeuw that "It should plane slow or fast and return fast or slow without spending much time in changing drive."

A planer slow enough for all work is better than one that is too fast for some work. Some planers reduce the cutting speed by reducing the speed of the countershaft by a variable speed drive, but that process is cumbersome, apt to be slow in manipulation and is somewhat uncertain in results. Worse than all that, it reduces the speed and, therefore, the power

that is transmitted to the planer through the driving belts. The belt ratio should be greater on the slow than on the fast cuts, because usually the slow cuts are the heavier.

In the Chandler planer the speed reduction is accomplished by a back gear in the gear train, and is operated by a lever on the operator's side, so that either speed can be instantly and positively had while the planer is in operation. To change the speed of the return stroke the operator simply raises or lowers a latch on the reversing dog. This latch puts the high-speed belt into, or keeps it out of action, and is manipulated instantly.

Closely associated with the speed in high-speed planers is the question of feed control. Increased cutting speed, strength of planers and steels makes possible a wider feed range. At the same time, if the planer is running more rapidly there is an increased difficulty in manipulating the ordinary feed adjustment, and a greater per cent of loss for every minute the planer is idle. On the Chandler planer the feed is regulated by a controlling lever which determines the length of the arc through which the friction box moves. The feed is thus put into the immediate control of the operator, who has no excuse for not using at all times the feed best adapted to the particular work he is doing.

Mr. DeLeeuw's article is such a clear statement of generally accepted theories that to offset it with other theories would not be a practical answer. We have, therefore, confronted it with actual conditions and actual results. If our planer is capable of doing what we claim our answer is conclusive. He or anyone else may put it to the test, and if we have exaggerated we cannot escape the consequence of our misrepresentation.

George J. Burns,
General Manager of Chandler Planer Co.

Ayer, Mass.

This letter, in reply to Mr. DeLeeuw's extended article upon high-speed planers in the June number, was received last month, but too late for the August number.—Editor.

* * *

CROCKER-WHEELER-TERRY TURBO-GENERATING SET.

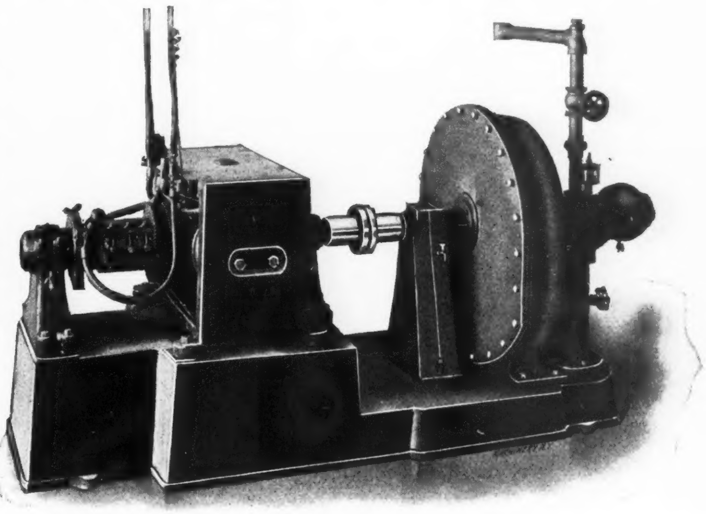
A 30 horse-power, steam turbine, direct current electric generating unit of novel design is shown in the accompanying illustration. The generator was designed and built by the Crocker-Wheeler Company, Ampere, N. J., and the turbine is the invention of Edward C. Terry, Hartford, Conn.

In the generator it was not found necessary to introduce any special features to help out the commutation, which is well taken care of by the standard Crocker-Wheeler design. The ring that carries the plain carbon brushes is provided with means for shifting them, but it has been found unnecessary to do so. The generator has carried loads ranging from zero to full load for many hours at a time without sparking. Overloads of 50 and 75 per cent have been carried for half an hour without sparking. A factor favorable to the sparkless commutation is the ample brush-contact surface.

A long commutator running at 2,500 revolutions a minute offers no small difficulties to the designer. This one is well within the safe limits, as was shown by running the completely wound armature at a speed of 4,500 revolutions a minute. A microscopic examination of numerous parts of the armature and commutator showed that the stresses in no part had approached the elastic limit.

In the turbine the force producing rotation is directed tangentially to the periphery of the wheel, completely avoiding end thrust. The velocity of the moving steam is not all absorbed in a single impact or in a single bucket. The buckets of the wheel are encircled by similar stationary buckets or reversing chambers, which return the steam to the wheel after each rebounding until all of its effective energy has been abstracted. The wheel consists of two steel disks secured to a cast-steel hub on the shaft and bolted near their circumferences, where they clamp the forged buckets. The reversing chambers are fastened to the case and are grouped in sets of four, each group being supplied by a separate jet. These sets are each operated by a valve, thus enabling one or more jets to be closed, and those in use to be used to their full capacity, when less than full load is required of the turbine.

The buckets and reversing chambers are essentially flat semi-cylinders, with their open sides facing one another. They are formed of plates on the broad sides, with curved walls set at right angles to the plates. These chambers are arranged in a circular series, lapping one upon the other in the form of a series of steps—that is to say, the axis of the



A Compact Turbo-generator.

several buckets and chambers are set obliquely to the circumference of the wheel. Their open edges are inclined at a slight angle with the axis of the shaft, so that steam, after being reversed in each chamber, is delivered to the next succeeding bucket, this being repeated four times. Steam issuing from the jet passes to the bucket, and from the bucket to the reversing chamber, back again to the bucket, etc., until finally it escapes through a crescent-shaped hole in the central part of the reversing chamber. The wheel being in motion, this action does not take place between the same reversing chamber and the same bucket.

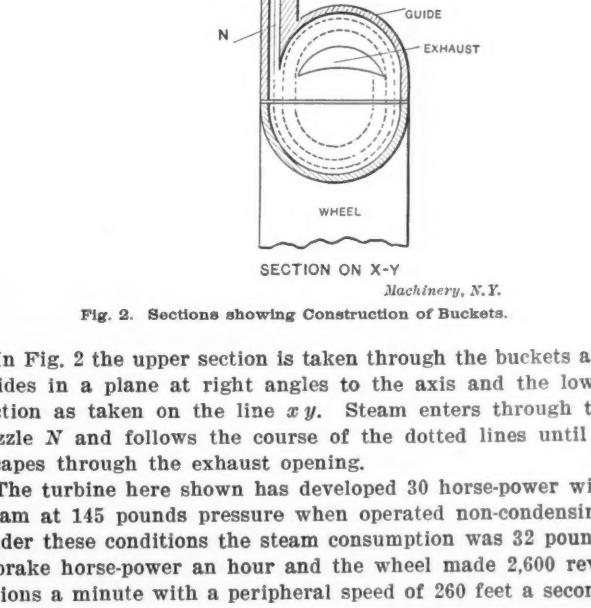


Fig. 2. Sections showing Construction of Buckets.

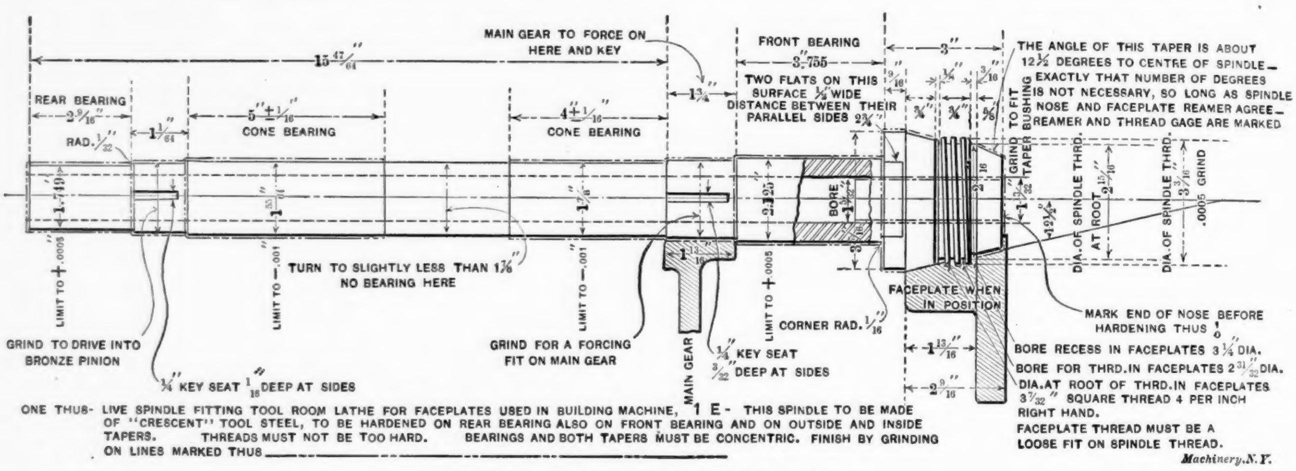
In Fig. 2 the upper section is taken through the buckets and guides in a plane at right angles to the axis and the lower section as taken on the line $x\,y$. Steam enters through the nozzle N and follows the course of the dotted lines until it escapes through the exhaust opening.

The turbine here shown has developed 30 horse-power with steam at 145 pounds pressure when operated non-condensing. Under these conditions the steam consumption was 32 pounds a brake horse-power an hour and the wheel made 2,600 revolutions a minute with a peripheral speed of 260 feet a second.

ITEMS OF MECHANICAL INTEREST.

SPECIAL LATHE SPINDLE.

Five or six years ago a Flather toolroom lathe in the shop of the George Gorton Machine Co., Racine, Wis., was fitted up with a special lathe spindle, as shown in the accompanying sketch, which we believe is of meritorious design. Its prominent feature is the nose, which is made tapering and is cut with a straight square thread of ¼-inch lead. The taper of the nose is about 25 degrees included angle, but as stated, the square thread is cut straight, and is made a loose fit. Hence, the moment that a faceplate is started, it is perfectly free to be twisted off by hand. Two flats ½ inch wide and 2¾ inches between their parallel sides are milled on the nose back of the faceplate fit for applying a wrench when necessary to start a faceplate loose. Obviously the construction is such that the tapered nose centers the faceplate exactly and no matter how many times a faceplate on which work is chucked is removed and replaced, it always centers exactly and runs as truly as though never removed, if ordinary precaution is taken to keep the nose clean. The design is the outgrowth of the needs of the shop for a lathe spindle on which faceplates could be removed and replaced or exchanged with the assurance that work chucked thereon would always center perfectly.



Spindle for Tool Room Lathe with Special Nose.

In reproducing the blueprint we have included the instructions of the draftsman which, as will be noted, are very copious and explicit. This is characteristic of the work of Mr. Carpenter, the chief draftsman of the company, as he believes thoroughly in the practice of making a drawing something more than a mere picture of the device to be represented; he regards a shop drawing as an instruction sheet which shall convey to the workman the fullest possible information as to the piece to be made and thus avoid any doubts or the need for verbal instructions.

TRAVELING HEAD PLANER.

Engineering, in a recent issue, gives a description of an interesting planer which has been built by Messrs. Joshua Buckton & Co., Ltd. The chief peculiarity of this planer lies in the fact that the table is stationary while the housings and tools move backward and forward, and in the fact that the tool holders are arranged to cut on both the forward and the return stroke. In this country at least such a construction is unusual. The planer has a capacity for work 6 feet wide by 4 feet high, and has a table 40 feet long. One great advantage of the moving housings and stationary table lies in the fact that work may be set up at one end of the table while the machine is operating on work at the other end. This does away with much of the lost time attending the operation of a large planer. The table of this machine has a cutting speed of about 40 feet a minute. Figures are given which show the advantage in point of economy of time of this arrangement of double acting tool holder over the usual arrangement of slow cutting stroke and quick return.

The firm for which this machine was built, who have been using it for some time, speak very well of the speed with which it does the work, the small amount of power consumed, and the stiffness of its general construction. One disadvantage of such a machine would seem to be the fact that the operator must travel back and forth with the moving housings to make the necessary adjustments; on the work, however, for which the machine was designed, such as surfacing locomotive frames, planing the tops of locomotive steam chests and other work which consists of large plane surfaces, this disadvantage would not be serious.

CONCRETE FLOORS IN FACTORIES.

In Report No. 17 of the Insurance Engineering Experiment Station, Boston, Mass., there is given some information on concrete basement floors which ought to be of value to machine shop owners. They have made an investigation into the use for this purpose of concrete, cement, and stone, in their various forms. They strongly advise against the use of a cellar in a shop building where it is not absolutely necessary. Such cellars and spaces are useless and noxious from every point of view and should never be tolerated unless rendered necessary for carrying shafting under the floors, usually a bad method. If such air spaces are provided they should be made as light as possible and should be ventilated, even if a forced circulation is required.

The true floor of a basement or of a one-story factory or work shop should be leveled up above the grade with gravel, sand, or rubble, and should be thoroughly drained. On this base a thick coating of tar, asphalt, or coal tar concrete should be spread. Trenches may be made in which timbers may be embedded in such concrete. When a plank floor is required it may be laid solid on the timbers with concrete, filled up and swabbed with coal tar so as to make a complete contact with the under side of the wood and so as to envelop the timber. Wood laid in this way on asphalt or coal tar products will last as long, or longer than any other wood in the mill. There have been examples under their supervision which have lasted for more than twenty years without noticeable deterioration.

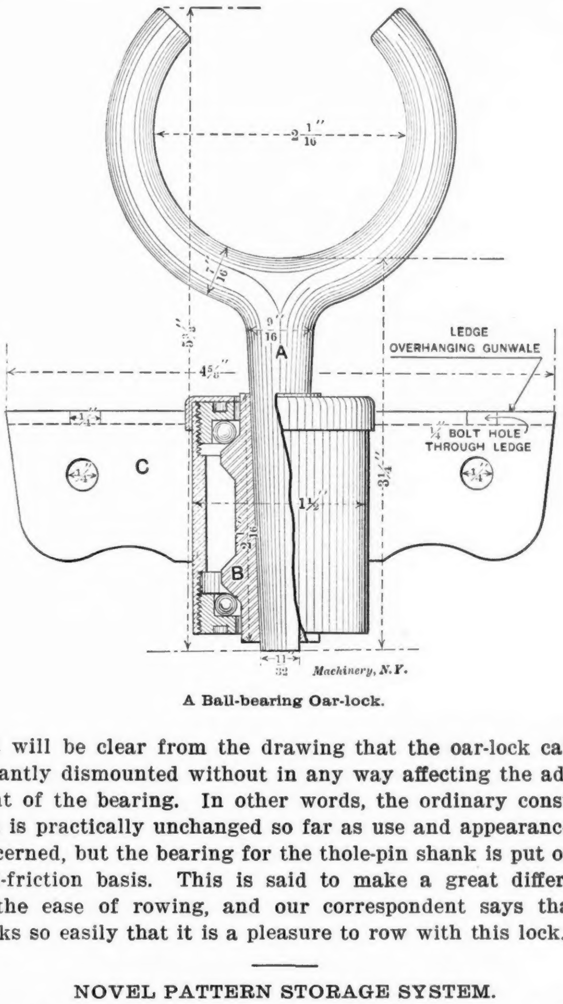
If a solid floor is needed without planking or timber, the concrete may be finished the same as sidewalks are now finished, and in some places concretes made with coal tar products are proving to be extremely serviceable in place of pavements on roadways. Since tank bottoms from the California oils and from coal tar products have lately displaced asphaltum, as we are informed, the products of coal tar are mostly in use in laying the floors. They are both antiseptic. They are non-heat conducting, impervious to water, and are therefore warm to the feet.

Cement concrete stone or artificial stone are not advised for basement floors or for the floors of one-story shops. They contain water in hygroscopic form. Wood laid in or upon such concrete is quickly destroyed. These materials are

ready conductors of heat and are therefore very cold to the feet. Under many atmospheric conditions they become absolutely wet; probably from the condensation of moisture from a warm, humid air.

A NEW USE FOR BALL BEARINGS.

Our occasional contributor, Mr. Arthur McAlpine, Auburn, N. Y., has sent us a blueprint showing a ball-bearing oar-lock which is being manufactured by a concern in Auburn. The cut is practically self-explanatory, so that little or no description is necessary. It will be observed that the thole-pin, *A*, is made with a tapered shank which fits into the ball-bearing sleeve, *B*. The frame *C*, on which *B* is mounted, is made with a ledge which fits over the gunwale of the boat and provides two additional bolt holes for attachment.



A Ball-bearing Oar-lock.

It will be clear from the drawing that the oar-lock can be instantly dismounted without in any way affecting the adjustment of the bearing. In other words, the ordinary construction is practically unchanged so far as use and appearances is concerned, but the bearing for the thole-pin shank is put on an anti-friction basis. This is said to make a great difference in the ease of rowing, and our correspondent says that it works so easily that it is a pleasure to row with this lock.

NOVEL PATTERN STORAGE SYSTEM.

The Brown Hoisting and Conveying Machine Co. of Cleveland, Ohio, have a pattern storage system which is very interesting. A brief description of it is given in the *Iron Trade Review*. The building is divided into comparatively narrow but high sections with fireproof partitions between them, and the patterns are stored on high narrow banks of shelves. To furnish easy means of access to these shelves a traveling crane has been installed in which the operator sits in a cage hung from the traveler, which can be raised and lowered the same as the hook in an ordinary crane. The operator thus has means of quick and easy access to any part of the storage shelves, and the storage space is kept very compact for the amount of patterns that is stored therein. The shelves themselves are made as nearly fireproof as possible, so that a small blaze would have difficulty in finding its way from one tier to another.

AN ELLIPSOGRAPH.

The unusual form of ellipsograph shown in Fig. 1 was constructed by Mr. J. J. Rexroth, 54 West Adams St., Chicago, Ill., and Fig. 2 shows examples of curves drawn with it. It comprises an annular stationary brass gear *D*, which is fixed on the drawing board, and a spur gear *C* having exactly one-half the number of teeth in *D*. To the spur gear is fastened an arm *B* across the diameter, to the outer end of which, in the position shown, is attached one arm of an ordinary wooden pantagraph. The fixture at *A* is adjustable on *B*, being shifted as the ratio between the major and minor axes of the ellipse is varied. The arm *B* has a slide pivoted in the middle of pinion *C* and engaged in the annular groove

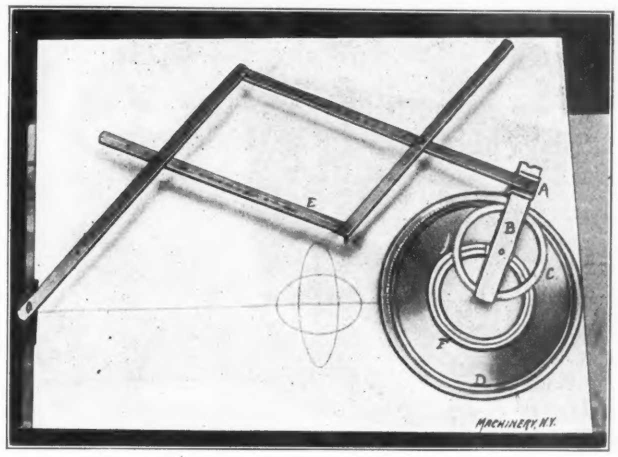


Fig. 1. An Ellipsograph.

in the ring *F*, which is attached to the back plate. The pivot in this slide thus forms a fulcrum around which *C* rotates and thus serves to hold it in mesh with *D* at all points of its travel. As stated, the ratio of the major and minor axes of an ellipse is determined by the position of slide *A* on the arm *B*. When *A* is coincident with the center of pinion *C* a circle is described as indicated at *F*, in Fig. 2. The axes of the ellipses are determined by the position of the arm *B* when radial; *i. e.*, whenever the axis of arm *B* coincides with

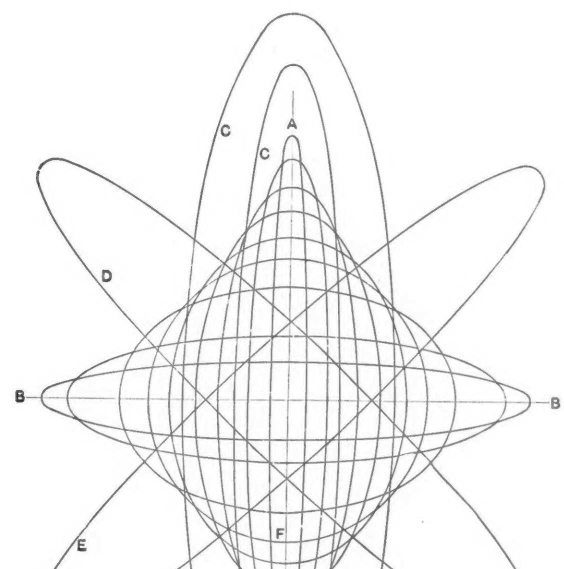


Fig. 2. Example of Work done with Ellipsograph.

any radius of *D*, then the major axis of the ellipse will be found parallel to it; and the minor axis, of course, will be at right angles to it. When *A* coincides with the pitch line of *C* and *D* a straight line will be drawn as shown in Fig. 2 at *AA* and *BB*. In short, the device is an application of the well-known principle of the internal epicyclic gear having one-half the number of teeth of the external gear. The pantagraph provides the means for enlarging or reducing the motion to the desired scale.

LETTERS UPON PRACTICAL SUBJECTS.

KINKS FOR DRAFTSMEN.

Editor MACHINERY:

When the adjusting nuts on bow instruments become worn out, they can be squeezed onto the screw in a vise as shown in Fig. 1, and their useful life continued. This must be done very carefully or they will be gotten too tight. I fixed a bow pencil clamp once in a similar manner with a little piece of brass, perhaps 0.025 inch thick and 5-32 inch square, through which I made a hole as large as the screw and then squeezed it as above on the screw. A slightly bent corner kept it from turning.

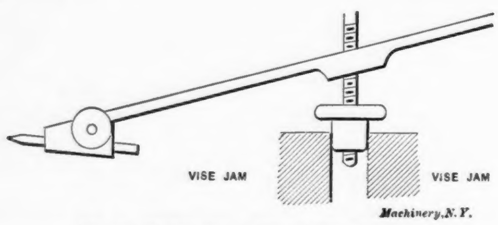


Fig. 1. Tightening a Worm Thumb-nut.

In place of a lost needle point, a fine sewing needle can be used by driving a hardwood sliver into the hole with it. The wood may protrude enough to act as a shoulder on the needle.

Celluloid Templets.

A very handy templet for drawing small curves and circles, where great accuracy is not required, may be made with a piece of thin celluloid. My templet, Fig. 1, is probably about 0.01 inch thick, and is a dark red tint, which is preferable to white. The circles are scratched deeply with bow dividers on one side, the center pushed through, and the same done on the other side until the piece can be broken out. By lightly scratching the center lines just beyond the outside of the circle before the center is removed, the hole can be located on center lines (see Fig. 2). On the edges, and particularly at the corners, are parts of circles with the center left and enlarged enough for the pencil point to go through to mark it. Sizes may be indicated by numbers giving the thirty-seconds of inch diameter. The holes should be cut slightly large to allow for

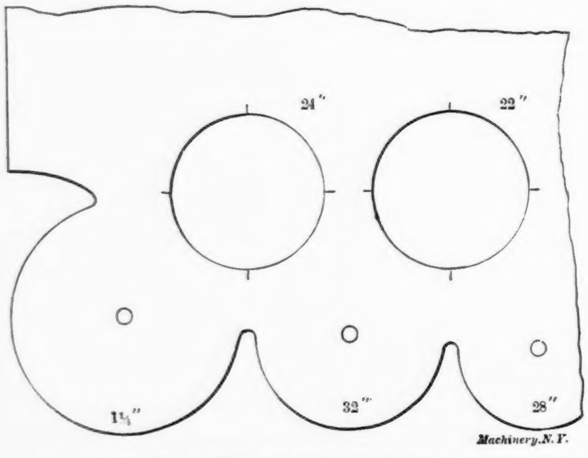


Fig. 2. Templet for Small Curves.

the pencil point; outside curves slightly small for the same reason. Similar templets may be made for the irregular shapes which are much used.

Special Scales.

A very convenient scale for one-half and one-quarter size work may be made by fastening strips of paper by shellac varnish just back of the graduations on a flat boxwood scale graduated full length with sixteenths on one edge and thirty-seconds on the other. On these strips mark the divisions and figure them, making the scale divisions equal eighths on the proportional scale (see Fig. 3).

I have similarly used a machinist's scale, with its advantage of deep graduations, by wrapping a strip of heavy paper lengthwise around the scale and fastening the two, with a screw at each end, on a beveled strip of wood, as shown in Fig. 4. With machinist's scales graduated to twentieths, twenty-fourths, twenty-eighths, etc., various odd proportions may be obtained.

Special scales may be made on paper or cardboard by laying off the larger divisions as convenient and making the shorter

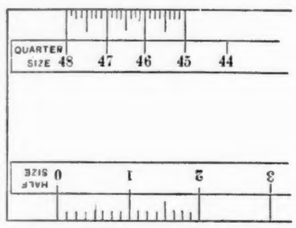


Fig. 3. Scale for One-half and One-quarter Sizes.

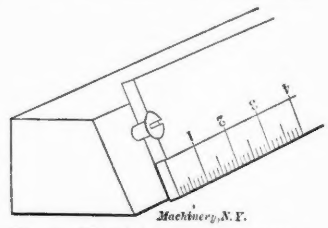


Fig. 4. Machinists' Scale adapted to Draftsmen's Use.

ones with a section liner. I have found very useful for this purpose one which consists of an old instrument screw turned into a slightly smaller hole in a piece of wood a little thicker than the diameter of the screwhead, and of such size that the two can be used in the central hole in a triangle as a block alone is sometimes used. The screw provides for a very fine adjustment of the spacing (see Fig. 5). Do not cut out the round corners in the triangle; it would cause a crack to start, if sharp.

T-square Tables.

One of the most convenient places for tables to which reference is often made, such as decimal equivalents, wrought iron

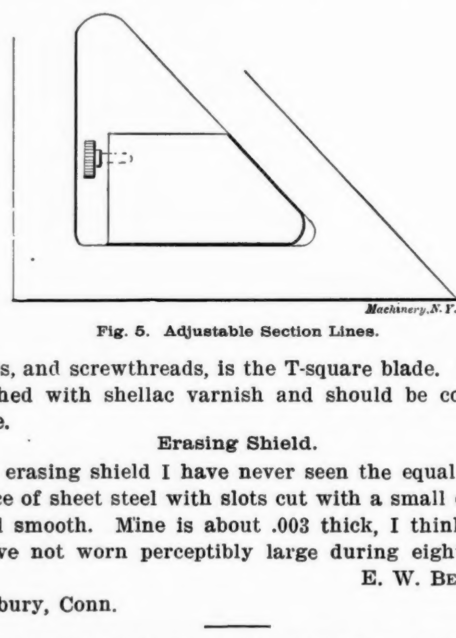


Fig. 5. Adjustable Section Lines.

pipe sizes, and screwthreads, is the T-square blade. They may be attached with shellac varnish and should be coated with the same.

Erasing Shield.

As an erasing shield I have never seen the equal of a very thin piece of sheet steel with slots cut with a small cold chisel and filed smooth. Mine is about .003 thick, I think, and the slots have not worn perceptibly large during eight years of use.

E. W. BEARDSLEY.

Waterbury, Conn.

CENTERING DEVICE FOR SCREW MACHINE.

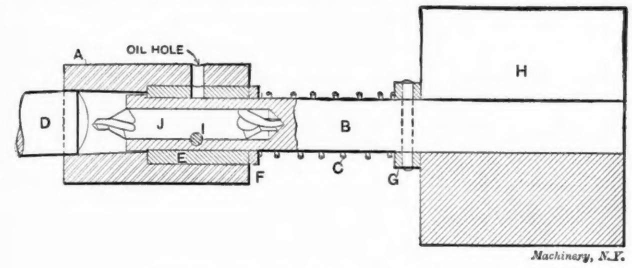
Editor MACHINERY:

Enclosed is a drawing of a screw machine fixture for centering piston pins, which I think will interest some of the readers of MACHINERY.

D is the piston pin, or any similar piece, in place in the chuck. The tool for centering it consists of a shank *B* gripped in a split bushing *H*, which fills the hole in the turret, a sliding sleeve *A* and a center drill *J*. The sliding sleeve is made with a tapered hole which fits over the end of the work *D*. As the turret is advanced the work enters this hole until it can go no further, and, as the motion of the turret slide still continues, *A* is then forced back against the pressure of spring *C*, revolving meanwhile with the work. It will thus be seen that the work is accurately centered with the drill. Continued motion of the turret brings the tool *J* into operation and the center is drilled to the proper depth as determined by the stop on the slide. Sleeve *A* is provided with a brass bushing *E* which forms its bearing on the shank, and has an oil hole drilled in it for oiling this bearing; the head

on the shank prevents the spring from forcing it off. A collar, *G*, held by a taper pin, furnishes the rear abutment for the spring. The center drill is held in place by a pin, *I*, put in Dutch key fashion. Care should be taken to get the pin in the center of the drill so that when one end is worn out and it is reversed to use the other, it will allow the same travel of the sleeve before the point enters the work, as before.

We use this fixture under a stream of oil, and after centering three or four pins we push the sleeve back and chips wash out easily. We make separate sleeves for different size pins,



Centering Tool for use on Screw Machine.

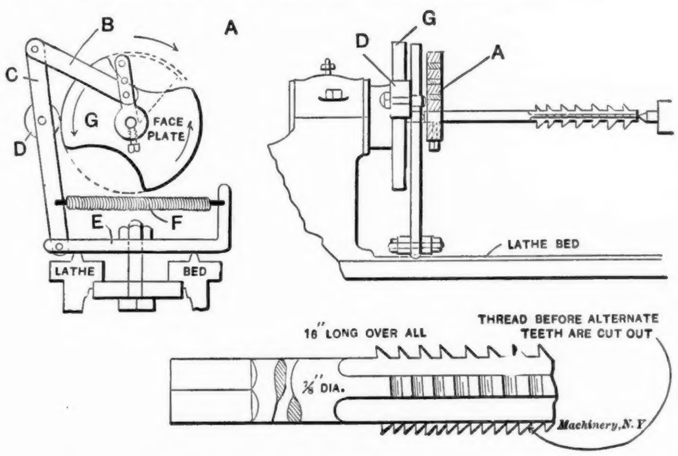
leaving the body of the fixture the same. This tool saves one operation on each end of the pin and also allows one end to be centered before cutting off, which, in turn, saves one chucking for each piece. It is unnecessary, also, to take a light cut over them in the lathe after centering, as was our former practice. The fixture gives satisfaction in every way.

Beloit, Wis. GERROLD HOWARD.

LATHE RIG FOR MAKING INTERRUPTED THREAD TAPS.

Editor MACHINERY:

We had occasion some time ago to make a number of interrupted thread taps for tapping a large number of steel nuts. A buttress thread was required, and we had found that using interrupted thread taps gave much better satisfaction, breakages being less, and less power being required for tapping. Then the question arose, how to make the taps quickly with the appliances at hand? We first ground out the alternate teeth, and then we chipped them out. Following that we put the taps in a lathe and used a lever on the faceplate to pull the tap around so as to cut out the alternate teeth with a tool held in a tool-post. Finally the idea was naturally suggested of making the lathe do the pulling, and I devised the simple rig shown in the accompanying cut.



Device for Cutting Interrupted Thread Taps.

A driver *A* was made for the taps, having an arm in which we tapped three holes for attaching the connecting-rod *B*. To the connecting rod was pivoted the rocking lever *C* which carried the roller *D*. The lower end of *C* was pivoted to a piece *E* which was clamped to the lathe bed, and which had one end turned up for the attachment of coil spring *F*. The parts *B* and *C* were made of ½ x 1¼-inch flat bar iron. *G* is an old faceplate of which we cut out two portions of the sides, as shown in the cut. In operation the spring *F* caused the roller *D* to follow the contour of the faceplate and rock the driver *A*, thus oscillating the tap back and forth as the faceplate revolved. The amplitude of the rocking motion of the tap depended upon the point at which the connecting-rod was attached to the driver *A*.

The taps were five-fluted, cut 8⅞ threads to the inch. A 40-toothed gear was used on the leadscrew and a 71-toothed gear on the spindle. W. LOACH.

Davisville, Toronto, Ont.

GRADUATING A SCALE ON A PLANER.

Editor MACHINERY:

Various devices have been described for graduating a scale; why a machinist should want to make a scale when one can purchase a scale of almost any desired graduation, I don't know, but more for a joke than otherwise the head blacksmith of a shop where I was employed a number of years ago asked me to make him one, and I did so—all on a planer at that.

First, I planed up the blank, leaving it hook-shaped on one end, out of a tool-steel piece 1½ x ½ x 33 inches long; the piece when finished was 1 x 3-16 x 33 inches long. By referring to the cuts, Figs. 1 and 2, an idea of how it was chucked

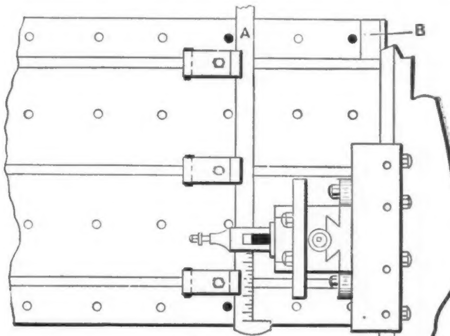


FIG.1

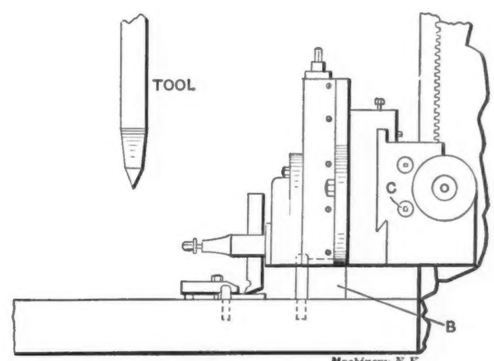


FIG.2

Graduating a Scale on the Planer.

for the graduating operation may be gained. The feed-screw on the cross-rail was single thread, four to the inch. By scribing a line at *C*, half of it on the rail and half on the feed screw boss, the quarter-inch graduations were easily made; the tool was set to the proper depth, and the feed screw was turned once around for every quarter inch. The planer was pulled by hand until the stop *B* on the platen rested against the rail. By changing the stop the lines cut on the scale were made different lengths, thus giving the inch, halves and quarter lines their proper length.

The inch lines were cut first, afterward starting over again for the half-inch and the same way for the quarter-inch lines. After cutting the graduations for 12 inches, the blank *A* was changed, that is, the tool was moved back to the starting point, and the scale placed under it so the point of the tool meshed in the last line cut; it was then clamped down and another 12 inches cut.

The finished scale was 32 inches long inside the hook, was fairly accurate and is still used by the head smith in that shop to-day. CARROLL ASHLEY.

Rochester, N. Y.

MAKING A BLANKING PUNCH AND DIE.

Editor MACHINERY:

For the benefit of readers of MACHINERY I would like to describe a few features in the making of a blanking punch

and die which diemakers do not run up against very often. As shown in Fig. 2, the die is of the usual follower type, excepting that the perforating dies *a*, *b*, *c* and *d* were to be solid instead of inserted as is usual in this class of work. Six of these dies were made, the only difference between them being in the length of the blank. Fig. 1 gives a good idea of the product.

After the dies were made up they were sent out to a concern that makes a specialty of hardening and tempering only. When the boy brought them back, or what was left of them, the boss's face was a sight to look at. One was broken square across the middle, another was cracked from the corner into the perforating hole, a third had lost all of one corner. The other three dies were all there, but had closed up so badly as

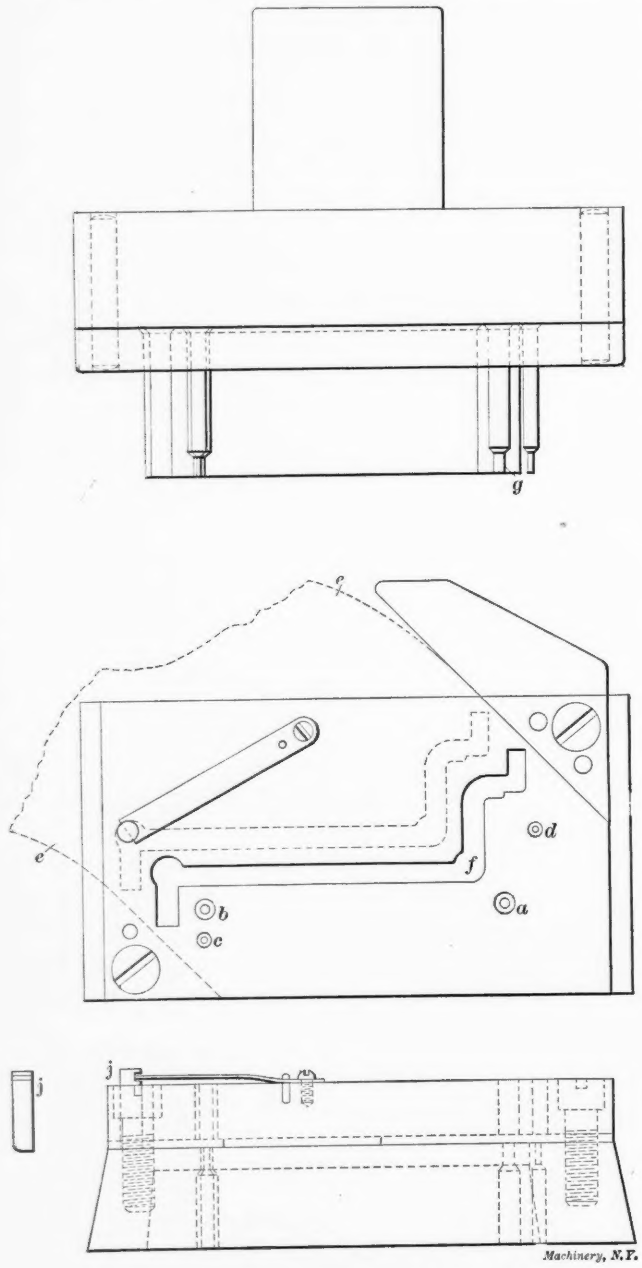


Fig. 2. Punch and Die for Making Blank shown in Fig. 1.

to necessitate annealing and filing over again to a template. After replacing the broken ones and fixing the others, they were given out again for hardening with some warm instructions accompanying them. They came back apparently all right and were set up and tried. When the stock was run through things went well for a stroke or two, but as we punched out more blanks, the waste stock began to assume the shape shown by the dotted lines *e*, *e*, finally jamming so tight under the stripper as to prevent feeding. After measuring up the die again, it was found that hole *a* had spread .0025 inch away from the center of its corresponding location in the blanking die at *f*. As the pilot pins were correctly located in the punch, this caused the stock to feed too far at the right-hand side by .0025 inch at the first stroke, .005 inch at the second, and so on until the waste stock had curved around to such an extent as to stop the feeding. Holes *a* and *b* were also found to be .0015 inch too near together, but this did not interfere with the operation of the machine, since the pilot pins could easily stretch the metal that much.

We tried first to remedy the error by making a new pilot pin, .0025 inch eccentric and putting it in place of pilot, *g*, Fig. 2. This made the hole come that much closer to the edge of the blank, which was quite noticeable, so it would not go. After considering the matter for some time it was decided to anneal the dies and counterbore, as at *h*, Fig. 3; then they were again heated to a cherry red and while in this condition were given an application of cyanide around the cutting edges, and put in the fire again for a few minutes to allow the cyanide to penetrate. The die was quenched as follows: A five-gallon ice cream freezer was produced and packed with salt and ice. The can was filled with sperm oil, and I turned the crank until the oil became thick from the cold. An interval of 20 minutes was allowed between the quenching of each die to let the oil become cold again for the next one. This made the dies hard enough for blanking steel without any further tempering, and without any danger of cracking from hardening twice. After this the die was again ground up.

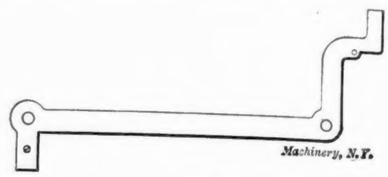


Fig. 1. Blank to be Made.

A machine steel bushing, .0015 inch eccentric, as shown exaggerated at *h*, Fig. 3, was made to correct the shrinkage of .0015 inch before mentioned. The thick side of this bushing

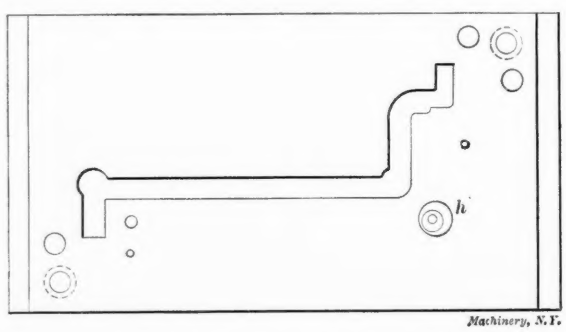


Fig. 3. The Way the Die was Repaired.

was marked and so located in the die as to bring the center distance correct. The perforating die was made next, hardened and ground on the outside by being held .0025 inch off center on a mandrel in an independent chuck. The thick side of this bushing was marked, and then it was adjusted in the machine steel bushing in such a position as to correct the error of .0025 inch referred to, and then driven into place. When again tried, the punch and die worked without any trouble. A stop pin, *j*, is used to locate the stock for each stroke. It is pressed down by the flat spring shown, and has its front edge beveled to allow the stock to slide under it. I am sending you for a sample, the thirty-five thousandth blank punched without grinding the die. H. R. HUBER.

Chicago, Ill.

TITLES AND BORDER LINES ON DRAWINGS.

The form of title is often settled by the office, but on the other hand the draftsman may be called upon any time to design a title. To be complete it should include in order of importance:

1. The name of the machine to which it belongs.
2. The shop symbol for the machine, if any.
3. If not an assembly of the whole machine the name, if there is a commonly used one, of the principal parts shown, as:

16-INCH ENGINE LATHE,
COMPOUND REST.

4. The words

   Assembly,

   Assembly Detail,

   Details,

according to which it is.

5. Date when finished.

6. Name or initials of designer and draftsman and any other person who is responsible for the drawing. The first four items above must be drawn in heavy type, large enough to be instantly read. The last two will meet all requirements if they are simply legible.

Where parts are numbered or lettered it would be a great convenience if alongside or just over the title, on a detailed drawing, a list of the parts by number which are shown on the sheet were given. While it is quite customary to put on the name of the shop where the drawings are used, it is a form of vanity which is not universal. Unless drawings are being sent out to other shops, or accompanying bids for work, they do not have even an advertising value.

The length of time to be allowed for making the title and border lines depends to my mind on about the same condition that a man's dress does. Border lines correspond to collars and cuffs and title to clothing in general. So we would no more leave a drawing without a title than we would go naked; but on the other hand, for shop use we would hardly dress our drawing up as for a reception. So in the shop I would leave out border lines altogether and put in the title off hand, being certain that it was clear and legible and always in the same corner of the sheet as the drawings lay in the drawer. But if the drawing is going out to help sell a machine, I would have a neat, clear title and a plain, medium border, and put in my best licks on it.

"ENTROPY."

FIXTURE FOR CUTTING SPIRALS ON THE PLAIN MILLING MACHINE.

Editor MACHINERY:

Thinking that it might interest you, I am sending you a photograph of a fixture which I have designed for cutting spirals in one-inch rods, shown in Fig. 1. The fixture itself is shown on a Brown & Sharpe plain milling machine and is driven by the regular feed gearing, as may be seen in the photograph, the telescopic shaft being disconnected from the gear box on the knee and attached to the short shaft at the base of the fixture. From here the motion is transmitted by

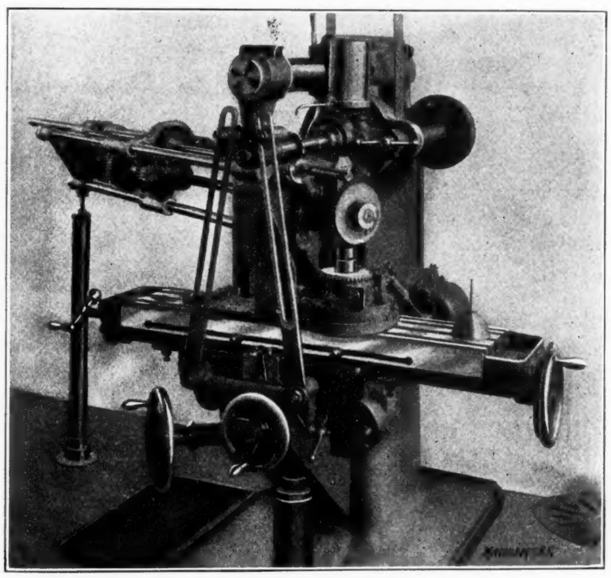


Fig. 1. Spiral Milling Fixture at Work

spur and bevel gears to the rotating gear which revolves the work, and the feed nut which feeds the head and the work forward toward the cutter. This head, which carries the rotating gear in whose hub the work is clamped, slides on the framework of rods seen in the cut extending to the left of the machine. Both right and left-hand spirals are cut by making simple changes in the gearing. At set-screw in the hub of the rotating gear enters a hole drilled in the work, and thus holds it while the cut is taken. When the other end is milled, the set screw seats in the grove already cut, and the milling the second operation removes the set screw hole used for the first. Besides this means of securing the shaft the gear hub is split and may be tightly clamped on the work.

If it is desired to cut larger spirals, the fixture may be extended by using longer distance rods and feed screw.

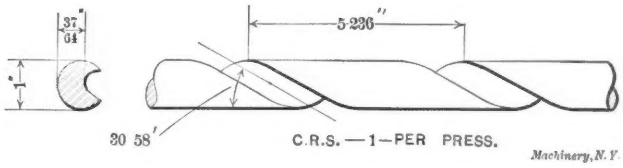


Fig. 2. The Spiral to be Milled.

About eight inches of finished work may be seen extending from the bushing under the cutter. The various bolts for making the adjustments are on the outside of the fixtures within easy reach. The machinists did a good job in making this apparatus, and it has given satisfaction without being changed in any way from the original design.

Pawtucket, R. I. HAMILTON RICE.

THE ADVANTAGE OF PRACTICAL SHOP TRAINING FOR THE DRAFTSMAN.

Editor MACHINERY:

The modern tendency toward specialization has had a deplorable effect on the draftsmen of to-day. There are few shops where the draftsmen, especially those who design tools and fixtures, ever follow up in the shop the drawings they make in the drafting room. This state of affairs, which inevitably leads to friction and misunderstanding, may to a large extent be avoided if the draftsman has had the necessary training to enable him to see clearly the actual performance of all the operations indicated by the drawing. To better illustrate this distinction between the strictly technical and the practical man I enclose a sketch of a jig designed to drill the two holes in a large quantity of the brass lugs shown in Fig. 1. The draftsman's instructions were to devise a method of quickly drilling any one of the different size holes in the same relative location in each end of the lug. The design of the first he drew out would undoubtedly have performed the work well, but before receiving the approval of the chief draftsman, the design was somewhat altered and cut down to the shape shown in Fig 2.

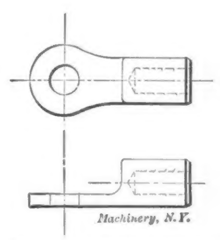


Fig. 1. Lugs to be Drilled in Jig.

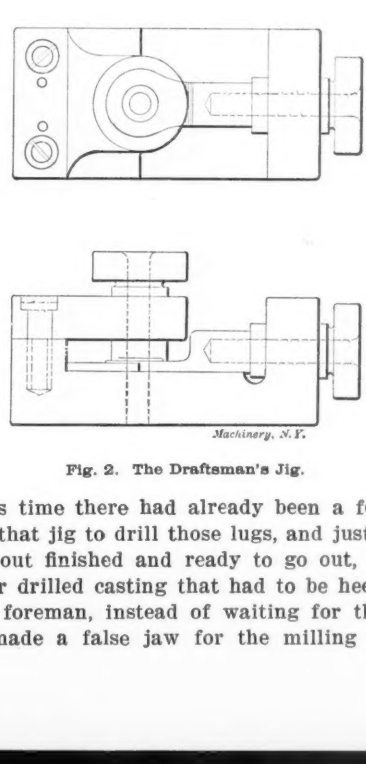


Fig. 2. The Draftsman's Jig.

During this time there had already been a few calls from the shop for that jig to drill those lugs, and just as the drawings were about finished and ready to go out, there came a hurry call for drilled casting that had to be heeded. At this juncture the foreman, instead of waiting for the completion of the jig, made a false jaw for the milling machine vise

with two V grooves, as shown in Fig. 3, and with the aid of a drill chuck in the milling machine spindle he drilled the entire lot before the toolmaker had fairly started on the jig. It would be an injustice to say that the draftsman was entirely to blame for the delay, still if he had had the foreman's shop experience he would have drilled the rush lot first, and designed the jig later.

Another instance of somewhat different character shows what a variety of talent is sometimes demanded of a draftsman. The large drill grinder used in the shop did more harm than good, because the boys, by overfeeding, drew the temper on every drill they attempted to grind. It was decided to convert it into a wet grinder, but you should have heard the howl that went up when the question of cost of tank, pump, piping and valves came up. Cost almost as much as the grinder itself, said the purchasing agent, as he looked at the elaborate sketch of the converted machine. But the draftsmen, who had by this time "got the hang of the job," evolved an idea which may be considered brilliant, and entitles him to consideration as a sanitary engineer. The water supply to the grinder, in accordance with his plans, was taken through a small galvanized iron pipe from the regular city supply, and the cast iron drip was drained through the floor into an open sink in the loft below, thus providing the grinder with a supply of fresh, clean, cold water, instead of the dirty, gritty substance which is generally used to cool the drill, but which clogs the pores of the emery wheel instead. Where the water supply is cheap and plentiful, the efficiency and low cost of maintenance of this method certainly compares favorably with the valve, pump, and tank system, which somehow is always in need of repairs. In fact, its trial in this shop was so successful that in the course of time all grinders in the shop were equipped in this fashion. In some of the larger shops complete piping systems of this kind are installed to supply lubricant to the cutting tools, to provide a constantly cool hardening bath, and for various other uses which have suggested themselves.

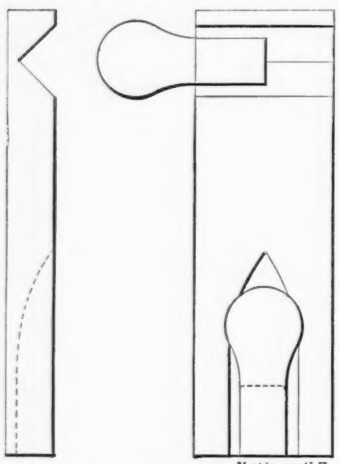


Fig. 3. The False Vise Jaw the Foreman Made.

H. J. BACHMANN.

New York.

AN UNUSUAL METHOD OF MAKING TUBES.

Editor MACHINERY:

The tools and operations described below were for the purpose of producing short tubes of steel that required to be made very accurately and therefore were machined inside and out; their dimensions were, 1½ inch outside diameter, 11-16 inch hole, and 3½ inches long.

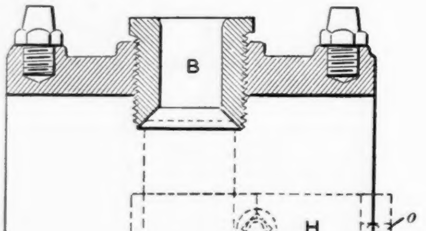


Fig. 1. Section of Jig for Drilling Tubes.

The pieces were first drilled in the jig, Figs. 1 and 2, using a heavy power-feed drill press; then reamed to size, and the outside turned off in a lathe on a special arbor. The drill jig that was used has a cast-iron body, *A*, consisting of a base, top, front and rear walls, but no side walls. Jig legs were provided for the base and the top, and there were bosses to

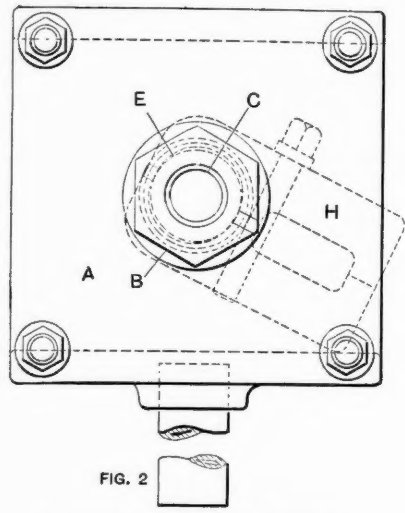


Fig. 2. Plan of Jig for Drilling Tubes.

receive the bushings *B* and *C*. The bushing *C* is driven in and pinned by a tangent pin, *d*, while the bushing *B* is threaded and made hexagonal at the outer end so as to be screwed in by a wrench. The inner ends of both bushings were beveled to an angle of 45 degrees, and served to center the pieces of stock, which before being put into the jig were slightly beveled in a press. The position of a piece of stock ready for drilling is shown at *E* in dotted lines.

To prevent the pieces of stock from turning in the jig while being drilled, clamps *H* were employed, consisting of two jaws *I* and *K* clamped together by a screw *L*, and kept in alignment by a pin *m*, in the jaw *I*, bearing in the groove *o* in the jaw *K*.

The parts of the jaws that come in contact with the piece of stock *E*, which is represented in the plan view of the clamp by the dotted circle, did not exactly conform thereto, bearing closely at *k* and *k'*, but were relieved at *p*, thus giving a wedging action as the screw *L* was tightened, and holding the stock *E* very securely.

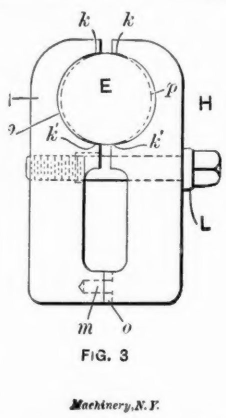


Fig. 3. Clamp for Holding Tubes.

Brooklyn, N. Y. C. D. KING.

PULLEY CROWNING.

Editor MACHINERY:

So far as I have been able to discover, the question of the crowning of pulleys has received very little attention from compilers of data for mechanics. It may be to many as it

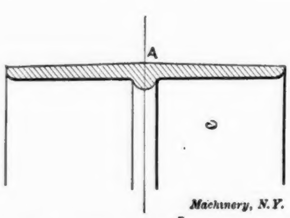


Fig. 1. Pulley with Straight Crown.

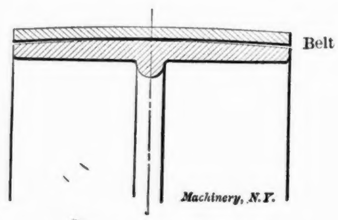


Fig. 2. Pulley with Curved Crown.

was to one mechanical engineer to whom I broached the subject, a matter not requiring any data. However, even he agreed that either of the common forms of crowning had the faults I pointed out; hence this attempt to start a discussion among your readers with the ultimate object, a machinery data sheet.

One form of crowning commonly used consists of two conical surfaces which meet at the center of the pulley face. Of course trouble results from the sharp edge (as shown at *A* in Fig. 1), which tends to crack the belt after long service.

The other common form is the arc of a circle. Now if the arc is of short radius to give the necessary amount of crown, the belt cannot bear across the entire surface, as that would mean an undue elongation of the center of the belt and no stretching of its edges, which we know does not take place. Hence it rides on the high part of the curve and an 8 inch belt becomes in effect a 6-inch (See Fig. 2). And if we make the radius sufficiently long, so that its entire face is in contact with the belt, the amount of crown is not enough for medium or high-speed belts.

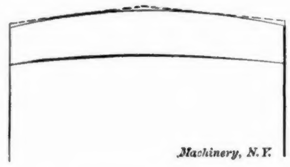
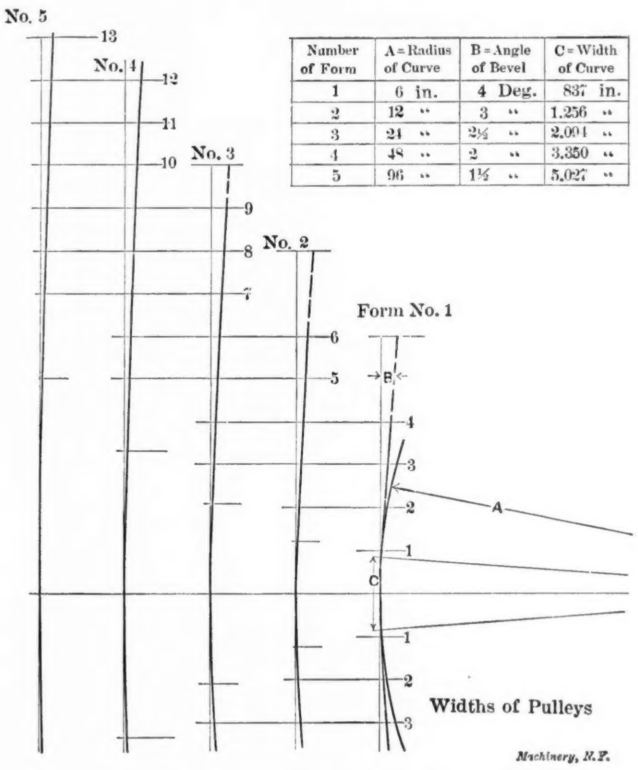


Fig. 3. Proposed Form of Crown.

But now let us combine the two as has been done in Fig. 3. The dotted lines show the two conical surfaces, the upper full line the arc, and the lower the two combined. The arc cuts off the high sharp edge of the two straight faces, and the tangents to the curve relieve that faulty dip at the end of the arc.

What should govern the amount of crown and where shall we place the limits? Kent says, under "Convexity of Pulleys:" "Authorities differ. Morin gives a rise equal to 1/10 of the face, Molesworth 1/24; others from ⅛ to 1/96. Scott A. Smith says the crown should not be over ⅛ inch for a 24-inch face." Interesting but hardly instructive.

Authorities certainly do differ. However, one thing seems to me to be apparent, and that is, that the amount of crown should increase with the belt speed. In the diagrams shown, five combinations have been laid out; for instance, No. 1 was laid out with the radius of the arc 6 inches and the angle of bevel 4 degrees. The center line of the pulley face is the horizontal center line of the figure, and the numbered horizontal lines indicate the widths of the pulleys in inches. The diagram is not extended full length below the center line, as it is the same above this line as below it.



Number of Form	A = Radius of Curve	B = Angle of Bevel	C = Width of Curve
1	6 in.	4 Deg.	837 in.
2	12 "	3 "	1.256 "
3	24 "	2½ "	2.094 "
4	48 "	2 "	3.350 "
5	96 "	1½ "	5.027 "

Fig. 4. Diagram giving Dimensions of Proposed Crown for Pulleys.

It will be noticed that in most cases each of these lines extends over three of the five different forms, thereby showing three different degrees of crown for each width of pulley, to be used for slow, medium or high speeds, respectively. At present our shop has in use Gisholt turret lathe formers corresponding to Nos. 1, 2, 3 and 4; the dotted lines show how much these formers overlap what is recommended for usual practice. GEO. A. GAUTHIER.

Hartford, Conn.

TWO TOOLHOLDERS AND A DIE MAKER'S SQUARE.

Fig. 1 shows a tool holder for use where the tool is formed on the end of a round bar. It is made of machinery steel and case-hardened. The hole is ⅝ inch in diameter and runs about ¾ the length of the stock. Its point of advantage over other toolholders lies in the fact that at *C* a slot is sawed clear through centrally and in line with the hole. In use, the tool post setscrew binds the web made by this slot and holds the inserted tool permanently in the desired position. The knurled thumbscrew has little to do, but adds its mite to the before mentioned setscrew, and takes out a "chatter" once in a while.

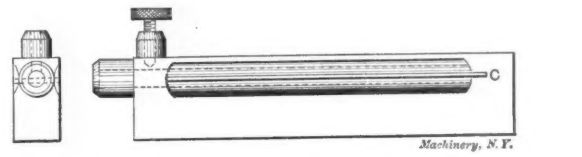


Fig. 1. Holder for Tools having Round Shanks.

A very convenient radius tool is shown in Fig. 2. As may be seen from the cut the tools are turned in the lathe to such a diameter as to give the radius desired. The toolholder I saw of this design was built to receive tools with a straight shank, but I believe it would be an improvement to make the tools for this holder with a tapered shank or stem, with holes to correspond, as shown by dotted lines at *D*. As the tools are to drive in and are used very much, a straight holder soon becomes a "slip fit."

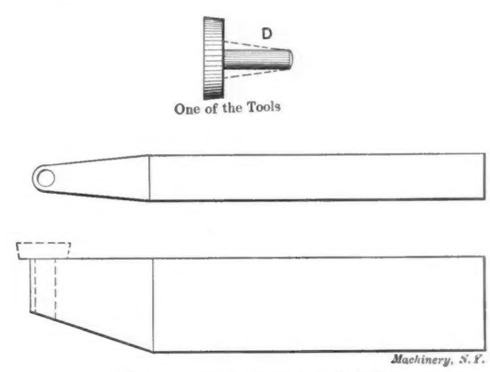


Fig. 2. Radius Tool and Holder.

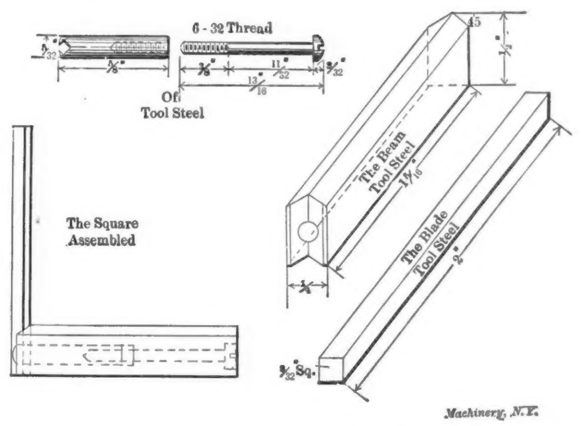


Fig. 3. Die-maker's Square.

Fig. 3 shows the best tool I have ever seen of its kind. It is called a "die maker's square," though it is exceedingly useful to other than die makers since it combines the functions of both the square and the depth gage. The plate and beam are hardened, ground and lapped. The picture will show the construction without any further explanation. I do not know just who devised this tool, but whoever he is he deserves a biography. CARROLL ASHLEY.

Rochester, N. Y.

A DRAWING ROOM INSTRUMENT HOLDER.

Editor MACHINERY:

Almost every draftsman knows how annoying it is, when making drawings where numerous instruments, triangles and other parts of the drawing outfit are used, to have them lying on the drawing board to have them handy. They are "always in the way," to say the least; they obstruct the view of the drawing, get mixed up with the T square or parallel

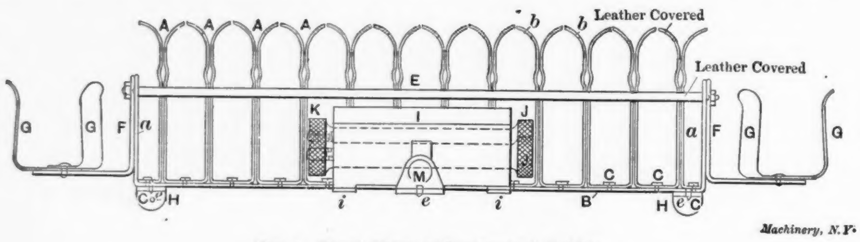


Fig. 1. Front View of Instrument Holder.

ruler, or, if the drawing board is inclined the right angle for convenient work, they slide off. To overcome the above difficulties I have designed a holder the success of which has led me to describe it for the benefit of other draftsmen.

The holder is shown in Figs. 1, 2 and 3. Fig. 1 is the front elevation, Fig. 3 the plan, and Fig. 2 an end view. It consists of a series of spring clamps *A*, 12 in this case, which are fastened to a base plate *B* by means of screws *C*. The springs forming the clamps are made of polished spring sheet steel .018 inch thick. The base is made of sheet brass

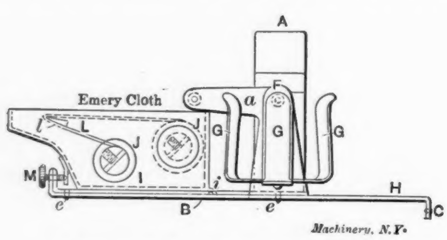


Fig. 2. End View of Instrument Holder.

1/16 inch thick, shaped out and bent at the ends to form the ears *a*. Holes are drilled in the springs large enough to freely admit a 3/16 inch wire rod *D*, Fig. 3; the rod has a thread and nut at each end which holds the ears *a* in place and also serves as a stop for thin tools inserted between the springs, such as triangles or scales. A second rod *E*, which is held by the extension of the ear *a*, also serves to support the ends of the long instruments held in the springs. The springs *A* are covered with thin leather down to and below the rod *D* on their inner surface, as are the rods *D* and *E*, which insures instruments and tools made of celluloid against injury. The tops of the springs are cut away a little over one-half of their width at *b* and on alternate sides so that one spring will not come in contact with the other when opened out; in this way a larger number of springs can be placed in a given space. On both ends of the base *B* and to the end of the case *a* are screwed the angular pieces *F;* they in turn carry on their extreme ends three springs *G*, which securely hold the drawing ink bottle. The angular pieces *F* can be adjusted to suit the inclination of the drawing board. As I use only one ink bottle, I have placed a receptacle in the other ink bottle holder for holding the rubber erasers and pen wiper.

Two narrow strips *H* are soldered to the bottom of base *B* and bend down at the end to hook over the top edge of the drawing board; and with the two needle points *c c* in *H* and the three in the base *B* at *e e e* the holder is securely fastened, but can be picked up and located in another place if necessary. *I* is a lead sharpener, and is contained in a box made of sheet brass 1/16 inch thick. The spindles *J* pass through the box and are locked by means of the shoulder *f*, Fig. 4, being drawn against the inner sides of the box by the nut *K*. Emery cloth is inserted in the slot *g* in the spindle and held by the headless screws *h*, Fig. 4. The emery cloth is drawn over a knife edge shaped piece *L*, which produces a very sharp edge (see dotted lines in Fig. 3), thereby enabling the lead to be sharpened in compasses that are almost closed by rubbing on the under surface at *l*. A new surface is produced by loosening both spindles and winding enough on one to present an unused part of the emery cloth, and then locking it; the emery cloth is then stretched out with the other spindle, which is also locked. I find that No. 90 emery cloth answers

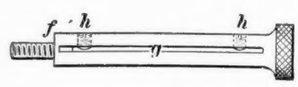


Fig. 4. Spindle for Holding Emery Cloth.

very well. To cleanse and remove the emery cloth, the box may be detached by loosening the screw *M* and lifting the two lips *i* out of the slots *k* in the base *B*.

CHAS. P. THIEL.

Lawrence, Mass.

* * *

The idea that every employe pays for superintendence has been expressed time and time again in various ways, but it is one that every man should thoroughly understand. The boy or man whose every effort must be directed by a boss must expect to receive the lowest rate of compensation. As he becomes more proficient and learns to do his work without ceaseless superintendence he becomes more valuable and his salary should increase in proportion as the need for superintendence decreases. When he acquires such proficiency that he is not only able to direct his own work but that of others, his compensation is not generally fixed by the law of competition so much as it is by the profits of the business in which he is engaged.

* * *

IN a discussion which has been in progress in the columns of the *New York Times* over the expression, "the tempering of copper," Mr. Arthur Jones Hopkins, of the Department of Chemistry, Amherst College, has contributed an explanation of the term which would tend to remove some of the mystery that has always surrounded the process. He says that the idea that the ancients were able to harden copper, arises from the thirteenth century misapprehension of the Greek word *baphê* —a word used by the Græco-Egyptian alchemistic writers of

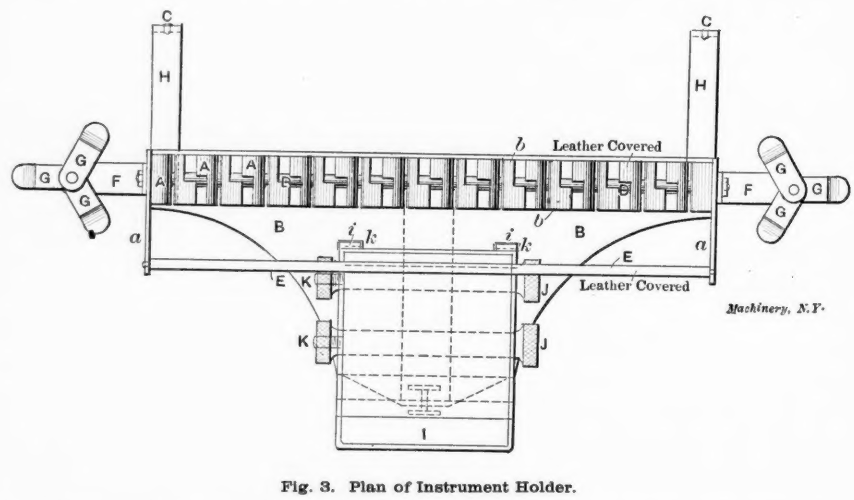


Fig. 3. Plan of Instrument Holder.

the third century. Berthelot, the eminent authority on alchemy, has shown that this word may mean tempering, coloring (of cloth, glass, and metals), the coloring materials, or the coloring bath. Egyptian alchemy was busied originally in producing brilliant bronzes on copper and the copper alloys; and this expression "the tempering of copper" means, and always has meant, bronzing copper so that it may stimulate silver or gold.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

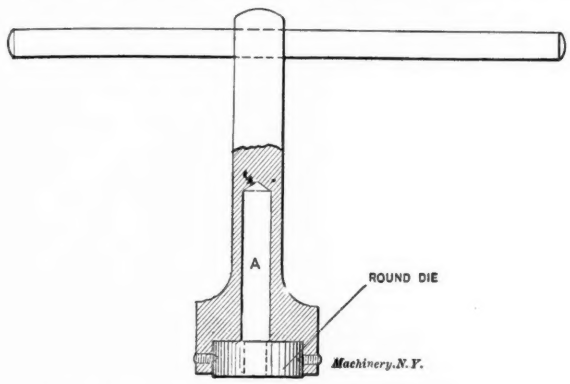
HOLLOW GRINDING CENTER REAMERS.

In order to make a center reamer of the plain style, easy cutting, use a 4-inch emery wheel to hollow-grind the flat face; by so doing the reamer will not only cut easier but will keep its edge longer. HARRY ASH.

Chicago, Ill.

A DIE SOCKET.

The cut shows a die socket which is a handy tool to have around; it can be used for running over the threads of U-bolts



or studs in place. The shank is drilled 4 or 5 inches to allow passage for the end of the bolt, as shown at *A*.

Schenectady, N. Y. R. B. CASEY.

A TOOL SUPPORT FOR CUTTING DEEP KEYWAYS.

Most of us are no doubt on "speaking terms" with the style of key-seating tool shown in Fig. 1 for use in planer or shaper. Some of us use it with cutting edge pointed downward; others point the cutting edge up. I prefer the latter method as the tool cannot spring away and the drag on the back stroke does not do harm enough to speak of. Sometimes it is necessary to

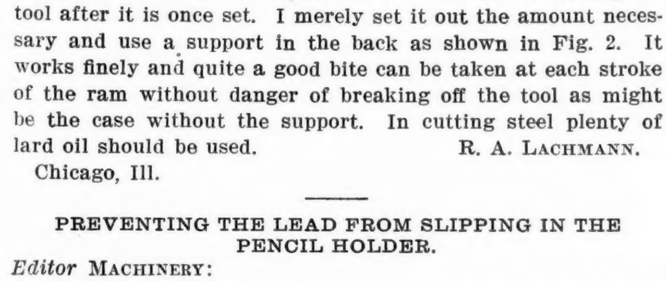


FIG. 1 FIG. 2

Machinery,N.Y.

cut quite a deep slot or key-seat in order to avoid shifting the tool after it is once set. I merely set it out the amount necessary and use a support in the back as shown in Fig. 2. It works finely and quite a good bite can be taken at each stroke of the ram without danger of breaking off the tool as might be the case without the support. In cutting steel plenty of lard oil should be used. R. A. LACHMANN.

Chicago, Ill.

PREVENTING THE LEAD FROM SLIPPING IN THE PENCIL HOLDER.

Editor MACHINERY:

I have enjoyed reading from time to time, the articles in your paper that are of interest to draftsmen. I am led to present what I consider a valuable little kink which I accidently discovered one day.

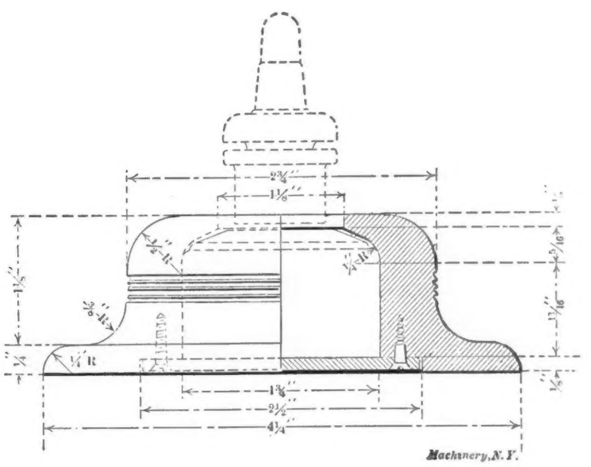
It is in connection with the artists' movable lead pencil holder. Every draftsman has had more or less trouble in trying to prevent the lead from slipping back into the holder after the chuck jaws have become a little worn from use. To overcome this the usual method is to screw the chuck sleeve tight until the threads are stripped or the clutch is loosened in the holder. Many good holders are short lived on this account, and this has prejudiced some draftsmen against the use of them. My method of preventing this trouble is as follows: I remove the chuck sleeve and lead, hold the pencil holder by the chuck jaws with thumb and finger, and with a small flat headed hammer, give the end of the jaws a succession of light rapid blows. This causes a burr edge to form on the inside of the jaws. Upon replacing lead and sleeve and tightening up with ordinary pressure, it is easily seen that the small edge on the jaws grips the lead firmly, making it impossible to force the lead back even when considerable pressure is brought to bear upon it.

I find that this simple method preserves the pencil for an indefinite length of time. S. J. B.

AN INK BOTTLE HOLDER.

Editor MACHINERY:

It's no use crying over spilled ink; just clean it up and then before you spill any more, get an ink bottle that will hold. Here is one made for a Higgin's drawing ink bottle that not only holds but is cheap, easy to make, light, neat, and will not tip over easily. Its construction does away with toothpick wedges and strips of paper to keep the bottle tight. The round piece fitted in the bottom is held with



four No. 4 wood screws ½ inch long. If the bottle does not fit tightly put a piece of card underneath. Any patternmaker can turn one out in a short time, and with a coat of shellac it makes a very presentable appearance. The straight, grooved sides make it easy and safe to handle. Three or four ¼-inch holes in bottom with old lead pencil rubbers forced in will make it non-slipping. D. C. TURNBULL.

Mishawaka, Ind.

POLISHING UNFINISHED SURFACES.

When polishing either cylindrical or flat parts which do not show up to good advantage owing to their not having a nice smooth finish (as, for instance, cold drawn stock which has not been turned or machined at all) a much better effect can be obtained if they are given a dull finish by criss-cross polishing. If the piece is round and can be run in the lathe, move the emery cloth back and forth while the work revolves and a nice effect will be the result. As to flat surfaces, I merely rub the emery cloth over them in all directions and this produces a very satisfactory appearance. R. A. LACHMANN.

Chicago, Ill.

TO HARDEN TOOLS WITHOUT DANGER FROM FIRE-CRACKS.

In hardening and tempering cutters, dies, punches, etc., where there is danger of breaking or cracking, many dollars may be lost or saved, according to the manner in which it is done. The following is a method I have used for all cases, whether the work be small cutters or large and expensive dies. First cover the cutting edge of the cutter or the design on the face of the die with a thick coating of paste made from ground bonedust and crude oil. Heat the work slowly until it comes to a cherry red. Use charcoal, and bank the fire completely over the work. When it has been well heated, cool immediately until the work can be taken hold of with the

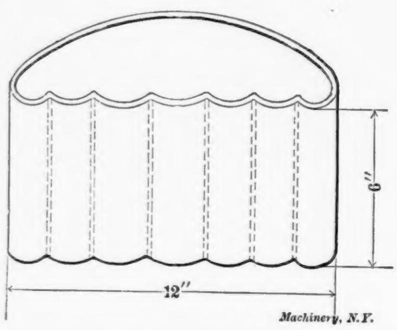
bare hand, then shut off the blast from the fire and again heat the tool until sawdust thrown upon it will burn. The work must be got into the fire as soon as possible after the first heating to prevent checking or cracking of the steel. The die or cutter can then be polished and the temper drawn without any danger.

With tools or cutters where it would injure the cutting edge or where the tool is so small that it cannot be polished for drawing the temper, the color may be observed by pursuing the following course: When the tool is first put into the fire and becomes hot enough to melt ordinary soap, rub soap generously over the face of the cutter. The potash in the soap will eat the dirt and grease from the metal and cause it to be perfectly white after it is cold. The temper may then be drawn in the usual way. JAMES F. COYNE.

East Providence, R. I.

A POCKET INSTRUMENT CASE.

It is notorious that few draftsmen have cases for their instruments. In fact, it has been said, that the difference between a fully qualified draftsman and an amateur is that the former keeps his tools in a cigar box. For carrying instruments about with one I have seen nothing so handy as the wallet, shown below. It is made of a single piece of chamois



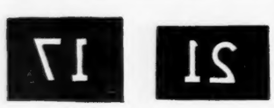
leather folded up to form a large pocket, which is then subdivided, by stitching, into separate compartments for different instruments. The cover folds over and the wallet is rolled up and tied with tapes attached to one end. It is then a handy size for slipping into the pocket. H. L. MILLER.

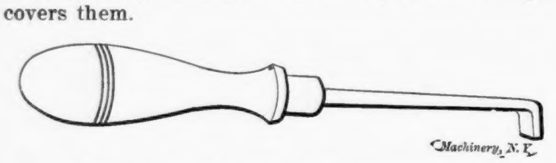
Manchester, England.

* * *

METHOD OF MARKING NEGATIVES.

It may be of interest to call attention to the method of marking negatives devised by Mr. H. E. Erwin and used in the drafting room of the New Britain Machine Company. We use a small scraping tool, like sketch below, to remove the film from the dried negative; this being done in any convenient place where the loss of detail will not be noticed. Over such a prepared spot is gummed a black rectangular slip from which the number of the negative has been punched by the office check punch. (Samples of these slips are enclosed herewith.) It is a very slight job to scrape the gelatine from the negative, and if the edges of the scraped portion are not absolutely perfect, it makes no difference, because the gummed slip covers them.





In the prints, the number of the negative then appears in dark letters on a light background, and the contrast between the two is as strong as the deepest tone and the highest light can give. The number, of course, serves to identify either the negative or print, and directs the proper filing of the former, in numbered envelope.

* * *

We have always supposed that the man who sat on the wrong side of the saw when he cut the limb off the tree was a mythical character, but according to a recent news item he is a living—or better, half-dead Italian. He lives in Bloomfield, New Jersey, and was sent up a tree by his employer to remove a limb which would interfere with a new building which was being erected. It was thirty feet to the ground and the Italian was seriously hurt.

* * *

Automatic machinery which performs some difficult operation is not usually so designed as to duplicate the manual action of the human operator, although the same result may be performed. The difficulty of handling the parts which form a product generally causes same to be modified in some way so as to be simply handled by the mechanism. A case in point is the shoe-pegging machine which makes its own pegs from wooden strips as the pegging proceeds; in this way the difficulty of handling small pegs and presenting them point foremost to the work is avoided. A similar operation of much greater delicacy is a riveting machine used, in making watch movements, for riveting the hook on the end of the mainspring. The handling of the minute rivets required would be, perhaps, an almost impossible accomplishment for any automatic machine; at any rate it is unnecessary. The way the difficulty is avoided is to punch the holes through both the hook and the mainspring simultaneously and to punch the rivets from stock supplied for the purpose. The next motion of the machine inserts the rivets punched out and heads them over. This process is an example of how the designer of machinery must adapt himself to the character of the product for which the machine is designed, and incidentally to take advantage of its cost. Now it is obvious that a machine for riveting boilers automatically could scarcely be expected to be efficient or economical in operation if the rivets were punched from stock the same as in the mainspring-riveting machine; aside from the cost the quality of the rivets would be very inferior. But the practice is admissible and desirable in the assembly of small mechanisms. In short, the designer of light automatic machinery generally has a license in the manipulation of the stock which is not allowable in the work of ordinary dimensions.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

Editor MACHINERY:

I offer the following as an answer to question No. 57, O. G., in the "How and Why" department of the August issue of MACHINERY.

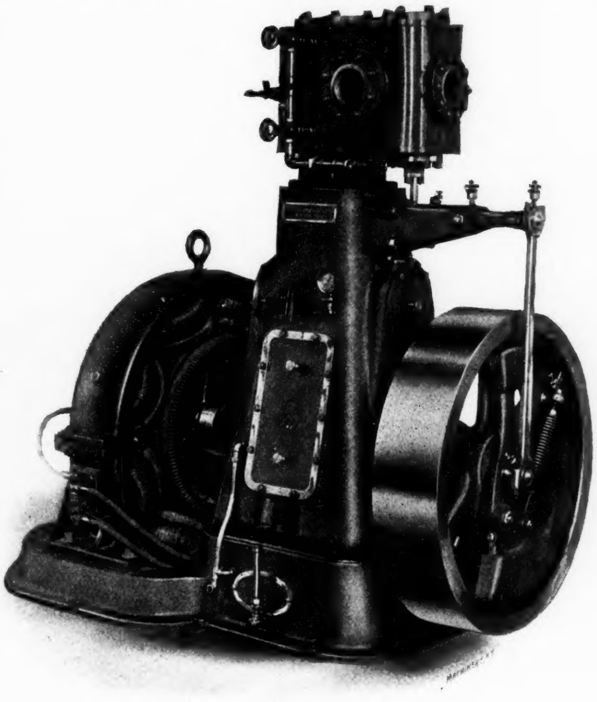
As there are a good many different kinds of high-speed steel on the market, and as these various kinds differ widely as to composition, it would have been possible to have given a more definite answer to the question had the latter contained information regarding what kind of high-speed steel the questioner had special reference to. However, there is one acid that will dissolve almost any kind of high-speed steel—most likely all kinds. This acid is composed of nitric acid (HNO_3) and hydrochloric (muriatic) acid ($H\,Cl$) in the proportions of one to two ($HNO_3 + 2\,H\,Cl$). This acid is known as nitro-muriatic acid, or aqua-rigis, and can be procured at any drug store. The writer has used this acid on several kinds of high-speed steel, and always with success. There is, of course, no question but that other acids can be used for different kinds of high-speed steel, and one would not have to be much of a chemist to find what acid or mixture of acids to use for etching such kinds of steel, if only the composition of the steel be known. For example, the writer happens to know the composition of Novo high-speed steel (probably the most used European high-speed steel on the American market) and as common etching acid had no effect on same, and the acid mentioned above at that time was not known to me, I used sulphuric acid ($H_2\,O_2\,SO_2$) mixed with water in about equal proportions. A slight amount of nitric acid was added to the above and gave still better results, although the steel could be etched without it. The reason for using sulphuric acid on this particular steel is very obvious to a chemist after he knows of what the steel is composed. A. A.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

STURTEVANT ENGINE AND GENERATOR.

The B. F. Sturtevant Co. of Boston, Mass., have just completed the design of a line of direct connected generating sets, of which we show an example in the accompanying cut. As may be seen, it is exceptionally pleasing in its general lines and proportions. The engine illustrated is of the single



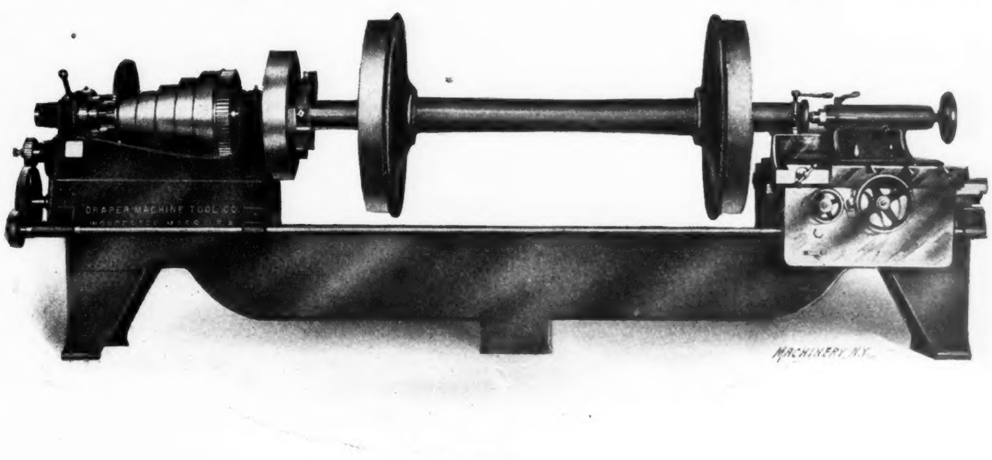
Sturtevant Generator Set.

vertical enclosed automatic type with cylinders 9 inches in diameter by 8 inches stroke. It is fitted with a balanced piston valve, is thoroughly insulated with magnesia and covered with Russia iron bound with polished iron bands. The regulation is accomplished by means of a Rites' fly wheel inertia governor, which is simple in construction and holds the speed variation within a limit of 2 per cent between full load and no load.

The generator was specifically designed by the manufacturers for direct attachment to its respective size of engine. The armature is of the barrel wound, toothed hollow drum type, the windings being of the coil or bar wound type. The field frame of the generator is of cast iron with wrought iron pole pieces and cast iron shoes. In the construction of the commutator the best drop forged copper is used, thoroughly insulated by selected amber mica. Soft carbon brushes are employed. The heat rise of the generator will not exceed 40° C. for a four-hour full-rated load run. An overload of 25 per cent can easily be carried for two hours. The complete set of the size illustrated weighs 4,900 pounds.

GAP LATHE FOR RAILWAY SHOPS.

The illustration shows a 22" gap lathe, especially adapted to steam and street railway service for truing car axles when the car wheels are in place, thus saving the time of forcing the wheels off, truing the axles, and then forcing them on again as is usually done. This lathe swings 22 inches over the ways, and will take a standard car axle with wheels in place over the gap. It has a 13-foot bed which takes 7 feet 8 inches between centers, and is furnished with a rod feed and plain block rest as shown.

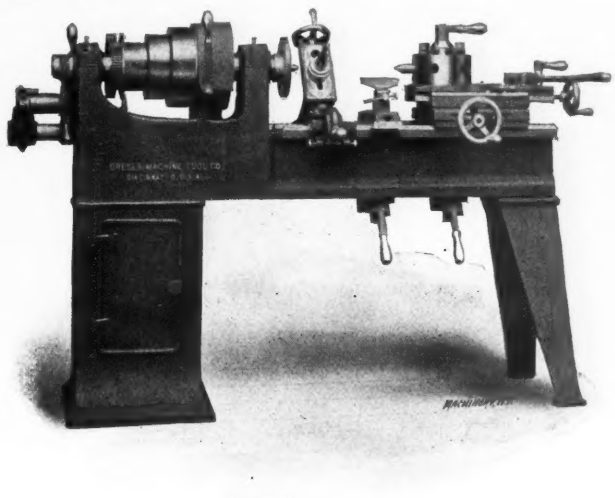


Gap Lathe for Railway Shops.

This lathe can also be furnished with a block to fill the gap, compound rest, leadscrew, and gears for screw-cutting, so that it can be used as a regular engine lathe when not being used for truing axles. It is made by the Draper Machine Tool Co., Worcester, Mass.

FIFTEEN-INCH FRICTION BACK GEARED MONITOR LATHE.

The accompanying engraving shows a turret lathe which is built by the Dreses Machine Tool Co., Cincinnati, Ohio. The bed is of the V top pattern and is seated on a three point bearing to prevent the possibility of springing and getting out of alignment through careless setting up or through the settling of floors and foundations. The tail leg is attached to the bed with a hinge and can be fixed to the bed by simply tightening a nut.



Back-geared Monitor Lathe.

The head stock is cast solid with the bed to insure strength and rigidity, and is provided with either phosphor bronze or babbitt metal bearings. The friction clutch back gear is simple and positive and enables the operator to use two speeds without stopping the machine. The wear is taken up by a screw driver from the outside. The spindle is made of a specially hammered crucible steel with an 1⅝-inch hole through it.

The turret is bored to receive six tools and revolves on a ground steel stem and is provided with an adjustment for taking up the wear. The index ring is of hardened steel, nearly the diameter of the turret, with ground notches for the locking key, which is withdrawn by the return stroke of the turret slide. The wear in the seat for this locking key

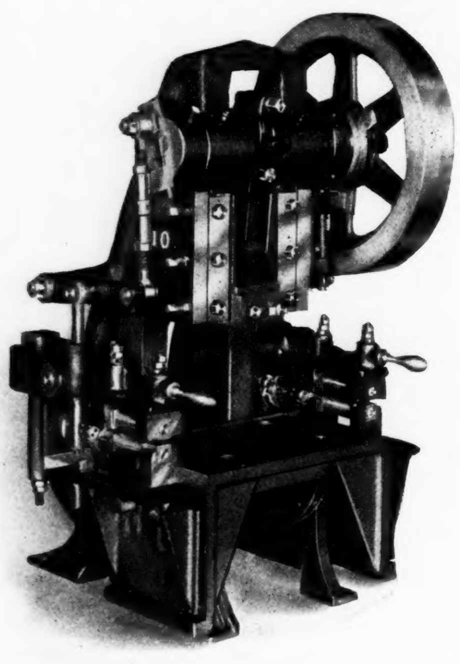
is taken up by a taper gib and differential screw. The slide is provided with both screw and lever feed. It moves in a square bearing with a taper gib the full length of the slide, for taking up the wear. The swivel slides are graduated and provided with an easily accessible clamping device. It has also a screw cross feed with graduated collar.

The machine is provided with a chasing bar which slides in three bearings on the rear of the bed. This chasing attachment will cut right and left-hand, straight and taper threads with the same nut and follower. The taper attachment is adjustable and graduated and is of such construction that the follower is not withdrawn from the nut when cutting taper threads. Nuts and followers for cutting 11½, 14 and 18 threads, and a double friction countershaft accompany every machine.

BLISS PRESS WITH SPECIAL DOUBLE ROLL FEED.

In the accompanying half-tone we illustrate a compact machine with a special automatic double roll feed, designed for cutting the teeth on band saws. The feed is adjustable and will cut either a coarse or a fine tooth from 16 points to the inch to 4 to the inch, common teeth.

An important feature of the press is the construction of the feed rolls, which are open at the end, allowing easy in-



Press Arranged for Notching Band Saws.

sertion and removal of the stock. The two small hand levers shown are used for raising the rolls prior to starting a new strip of stock or for removing an old one. The feed will permit a wide range of adjustment, which is effected by sliding the connection block up or down the "T" slot in the crank on end of the main shaft. This sliding movement is controlled by an adjusting screw which easily moves it to the desired location. The press has a one inch stroke with an adjustment of one inch. The distance from bed to slide when stroke is down and the adjustment up is 7½ inches. The fly wheel weighs 115 pounds and is run at 300 revolutions per minute.

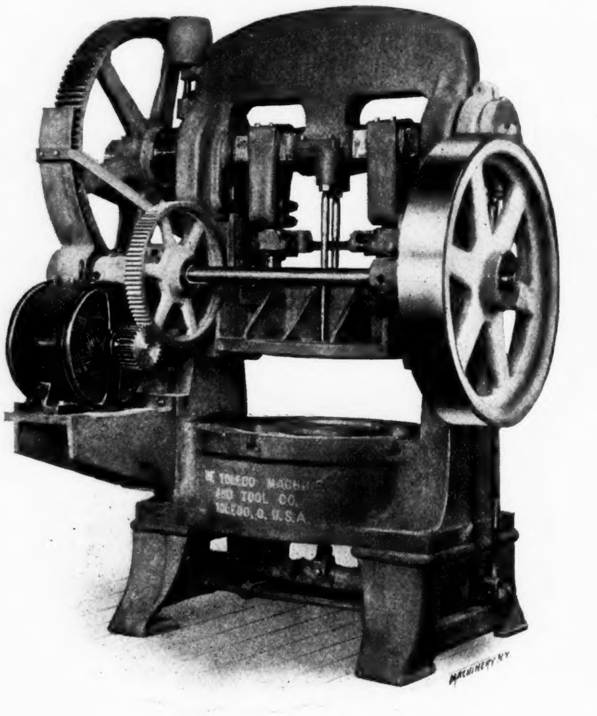
This press was built by the E. W. Bliss Co., No. 5 Adams Street, Brooklyn, N. Y.

DOUBLE PITMAN POWER PRESS.

The machine which we show in the cut is one of a line of thirteen sizes designed and built by the Toledo Machine and Tool Company, Toledo, Ohio, for blanking and perforating disks and segments for electrical work in the manufacture of dynamos and motors. The machine is fitted with a positive knock-out for both the slide and the bed, that on the slide being operated by the two adjustable rods seen projecting from the cap of the middle crank bearing. The lower knock-out is operated from the lever and vertical rod, shown on the right of the brace, by means of a cam on the crankshaft.

The machine, as shown, is direct-connected to an electric motor in such a way that the combination takes no more floor space than is required by the usual belt-driven machine.

The bed of the press is bored centrally with the slide down far enough to form a wide, substantial shoulder in the press



Toledo Blanking and Perforating Press.

bed. This is designed for fitting in the press bed, filler rings which are recessed to receive the dies, in this manner acting as a substantial guide for holding the dies rigidly in position.

GEM BORING TOOL HOLDER.

The halftone shows quite clearly the construction of this tool holder, which is designed to hold boring tools whose cutting edge is formed on the end of a round bar of stock. The principal advantages claimed for the use of this style of holder are: the fact that the boring tool needs to be extended only to the proper length to suit the work, thus avoiding

Gem Boring Tool Holder.

unnecessary limberness; its ability to hold boring tools of different sizes; and the firmness with which the tool is held, inasmuch as not only is it held by the clamp screw shown in the cut, but this is supplemented as well by the pressure of the setscrew in the toolpost of the lathe in which the tool is used. The Gem Manufacturing Company, Milwaukee, Wis., are the makers.

AN IMPROVED CENTER REAMER.

THE G. R. Lang Company, Cincinnati, Ohio, are making a center reamer which makes a center possessing distinct advantages over the usual style. As may be seen in the cut, the reamer is formed with a shoulder. In centering the work,